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(54) **Monitoring gearbox operation**

(57) A method for monitoring the functions of a motor vehicle transmission 311 coupled to an engine 300 via a clutch 302. The transmission 311 has at least one position-variable gearbox element 314 whose position change causes a change in the gearbox ratio. A sensor device 320 is provided which detects the position of this position-variable gearbox element 314 and a computer unit 350 is provided which checks from a predetermined assessment criterion whether this position-variable gearbox element is located in a predefined target position. With one embodiment of the invention this assessment criterion is detected within the scope of a learning process.

Fig. 10

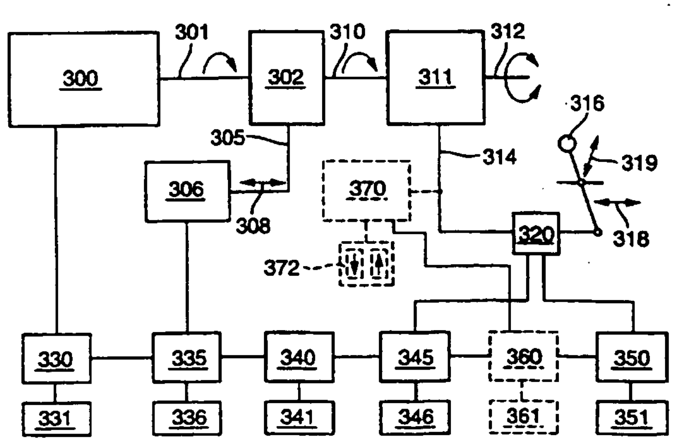

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Fig. 1

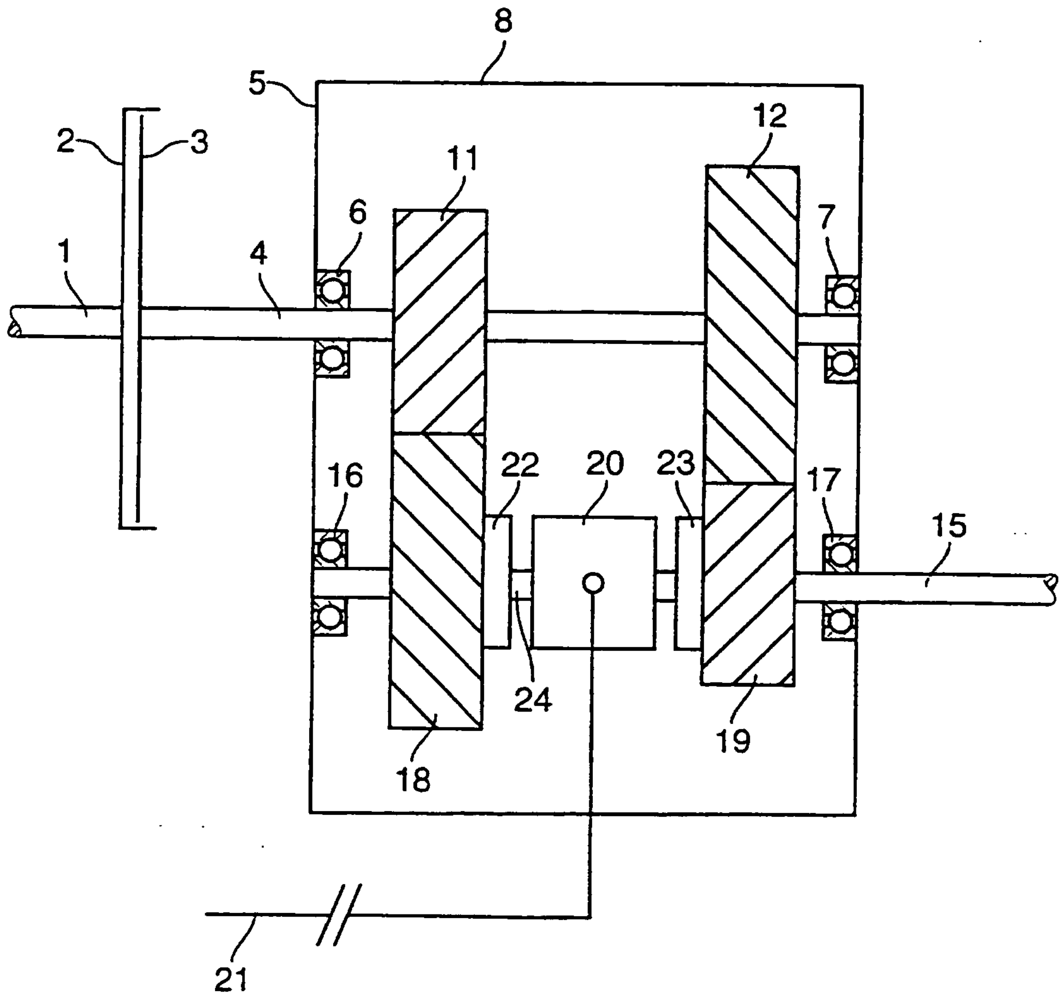

Fig. 2

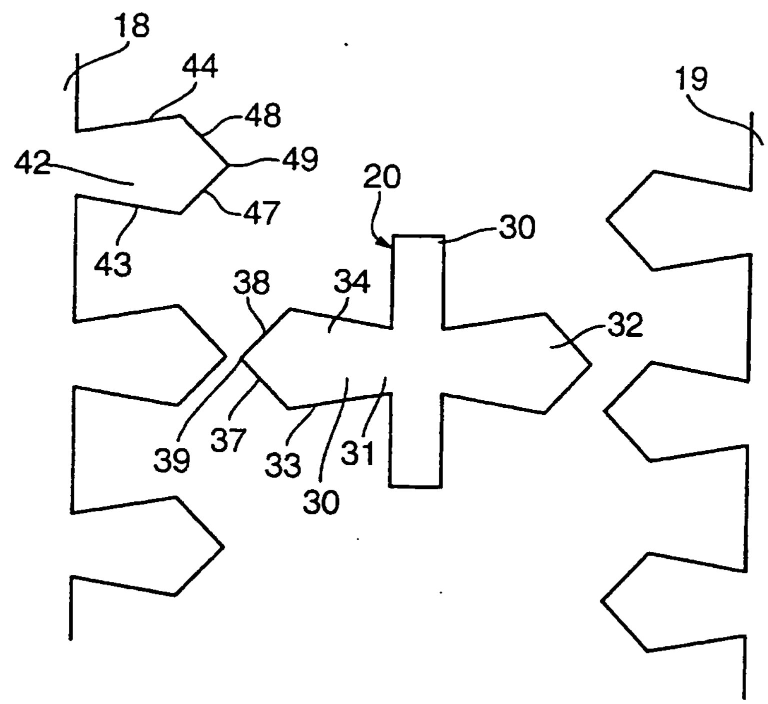

Fig. 3

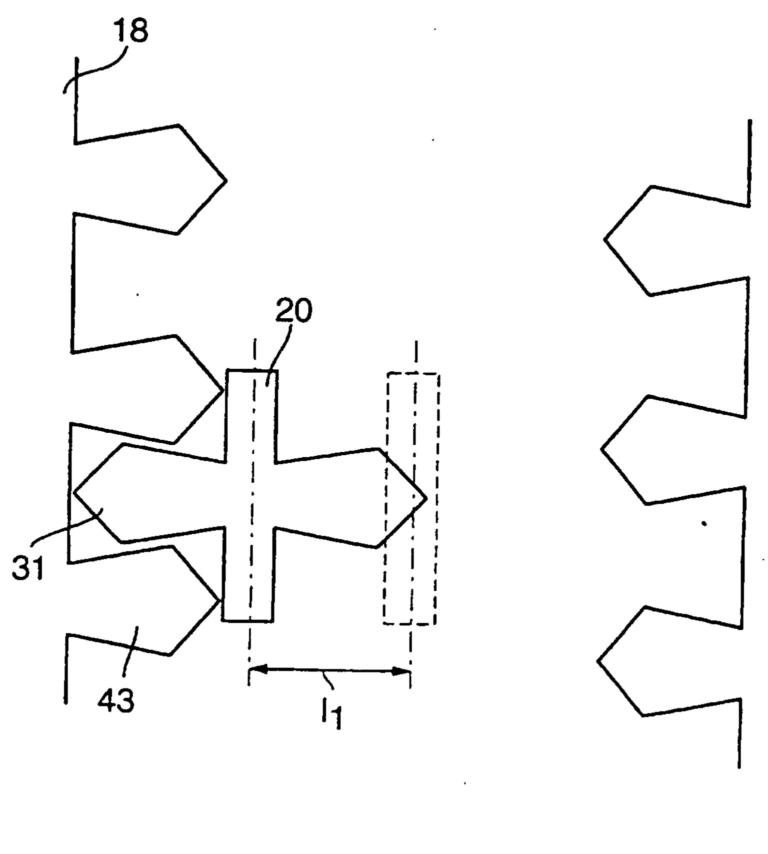

Fig. 4

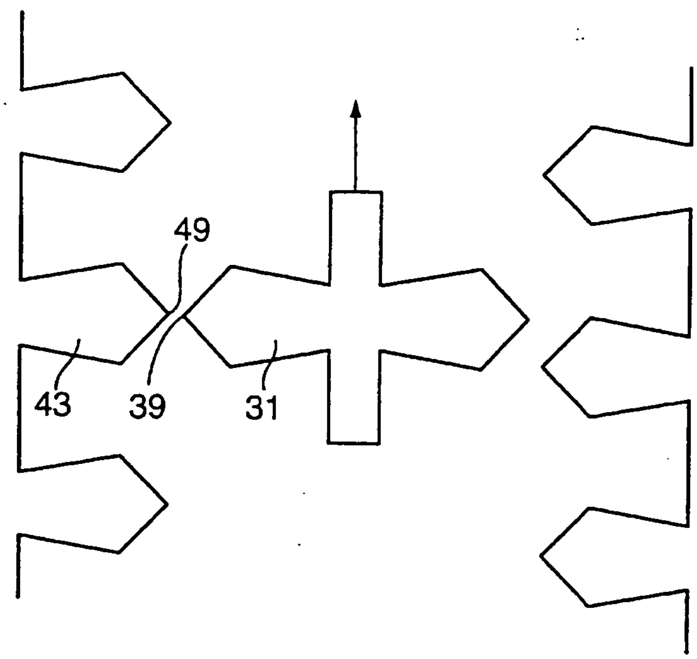

Fig. 5

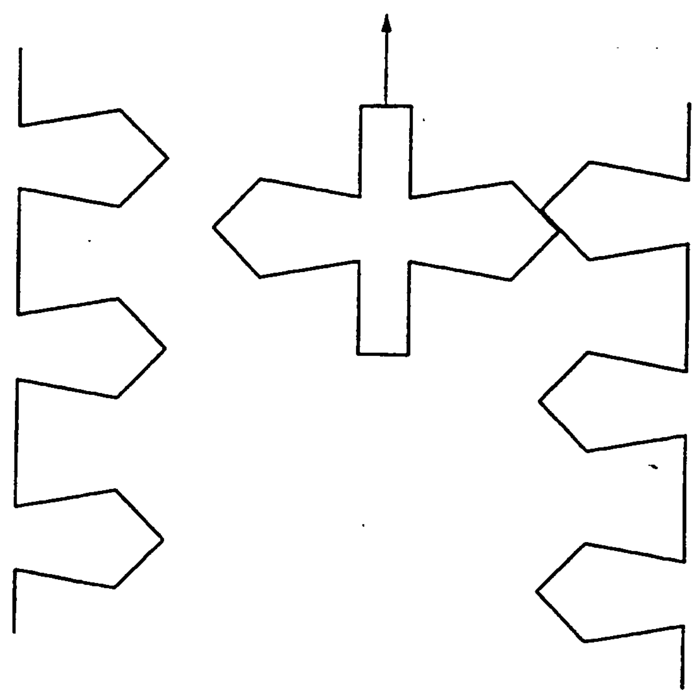

Fig. 6

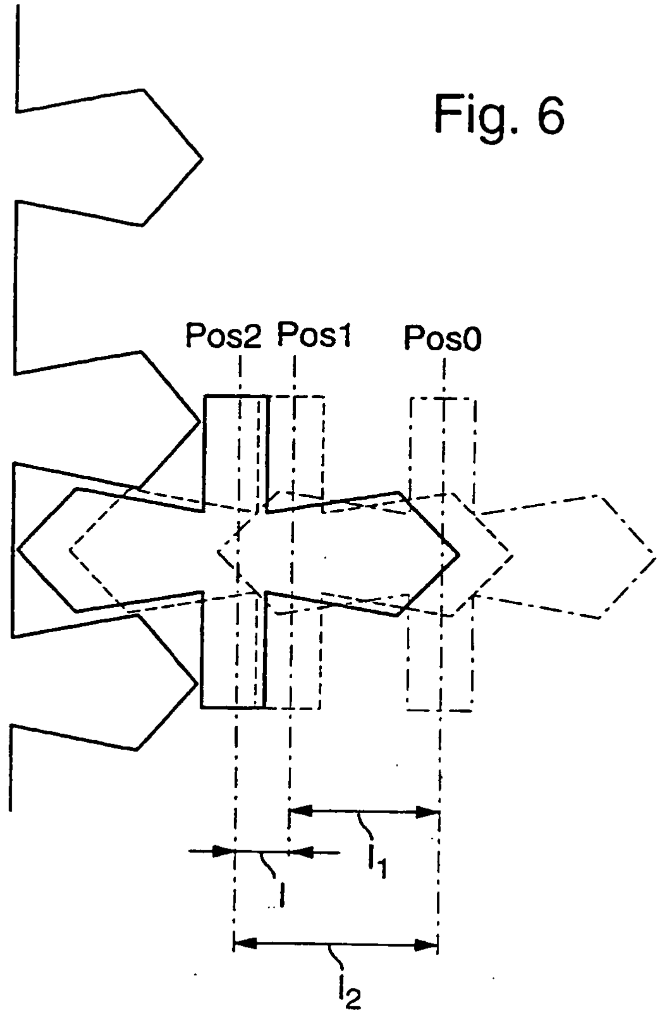

Fig. 6a

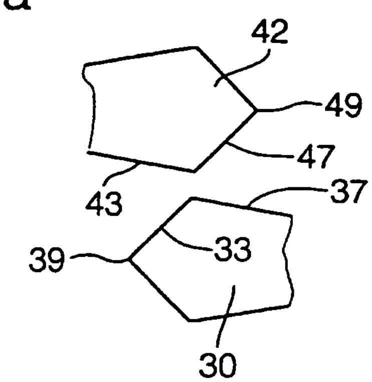

Fig. 7

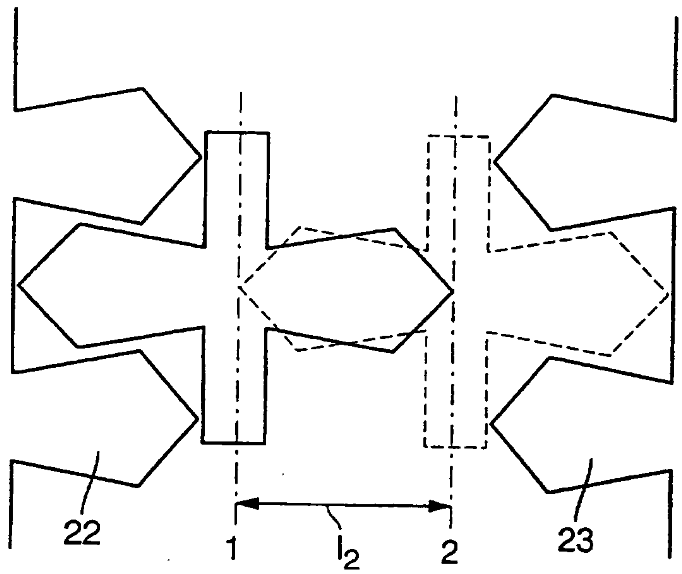

Fig. 8

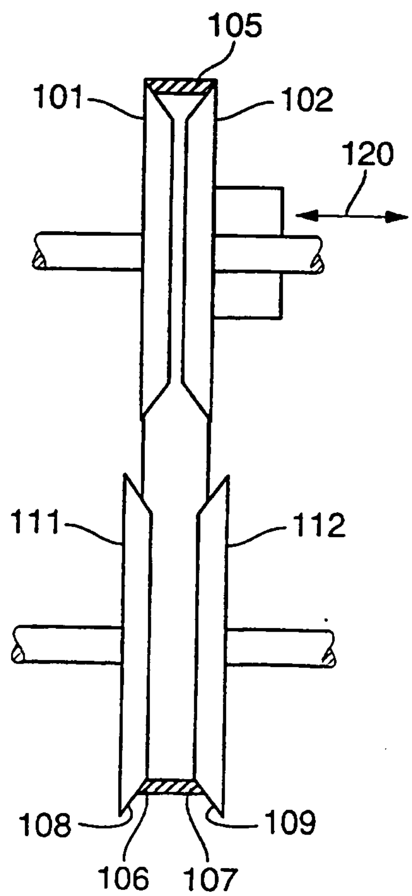

Fig. 9a

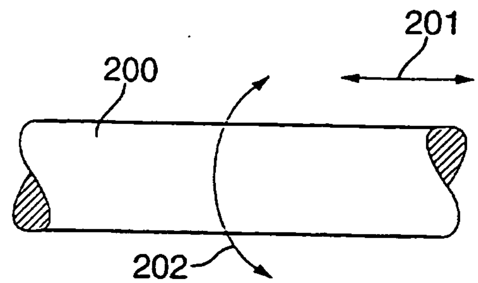

Fig. 9b

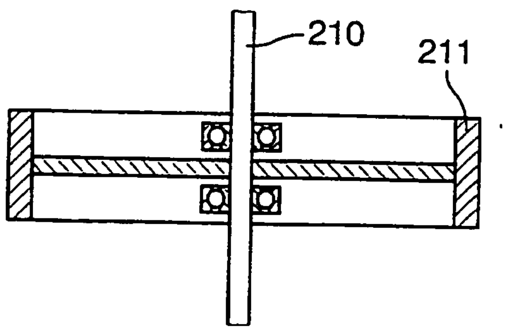

Fig. 9c

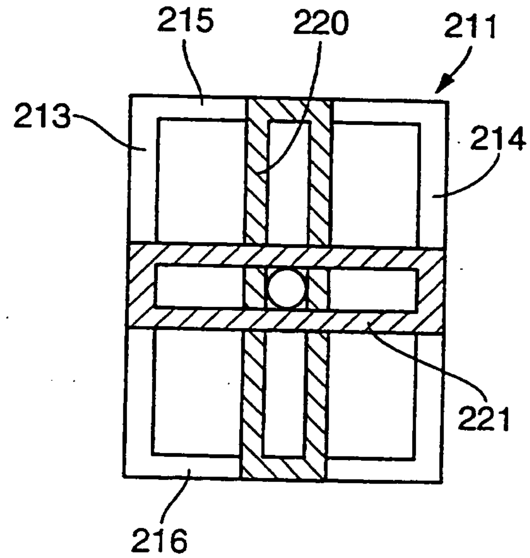

Fig. 9d

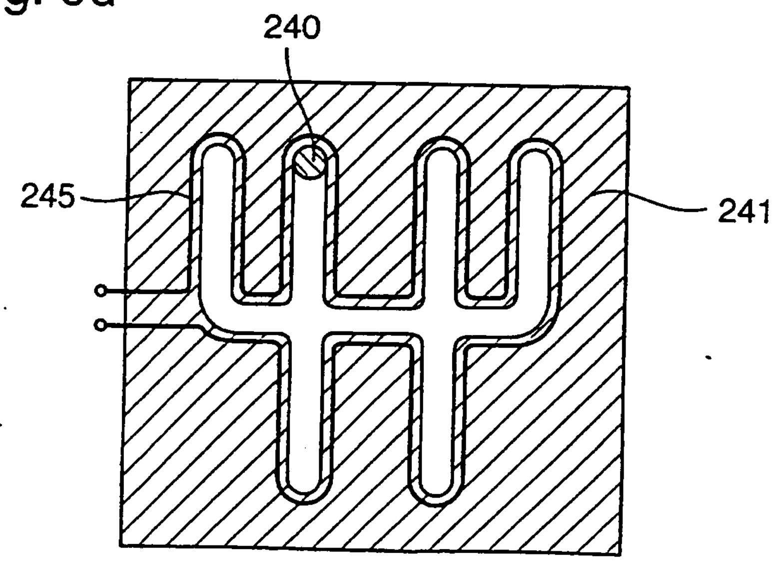

Fig. 10

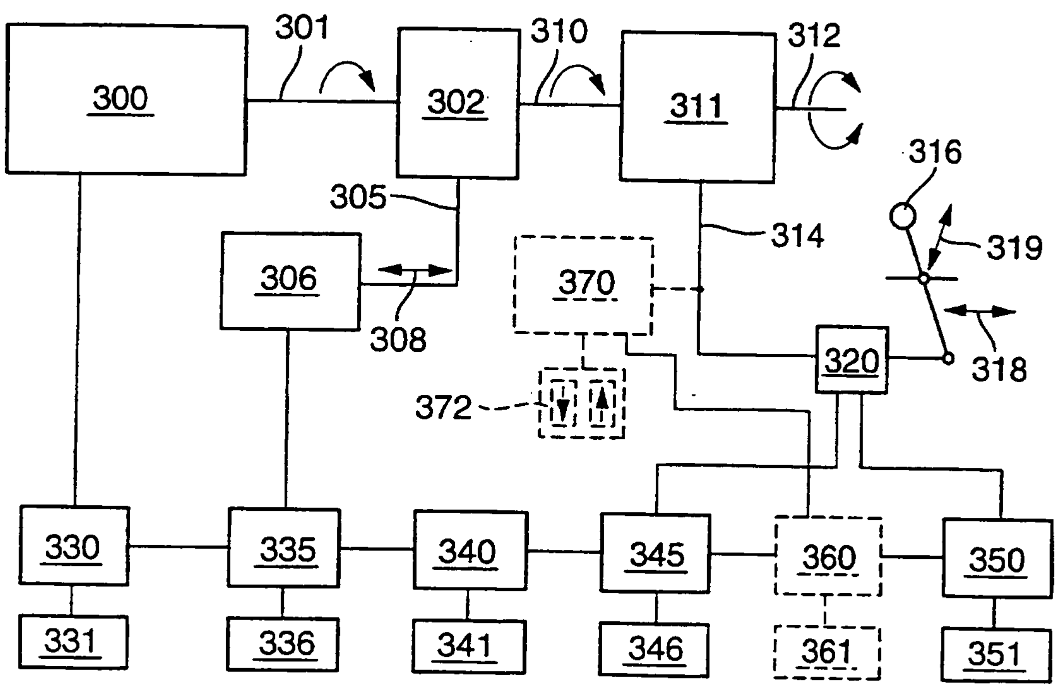
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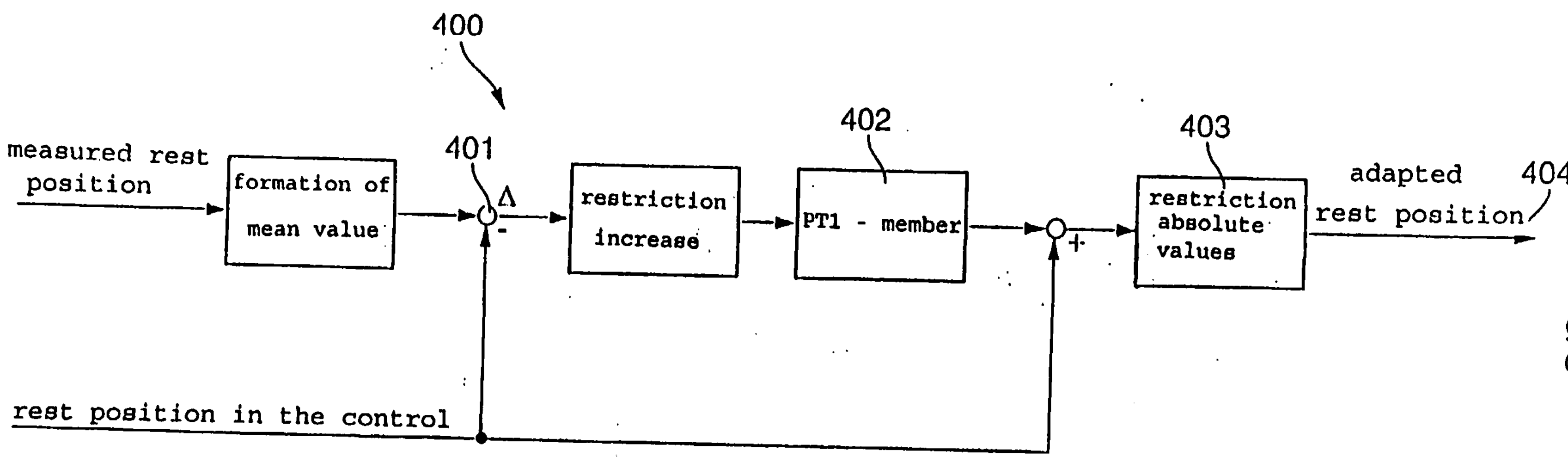
Fig. 11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Δ
-
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402
PT1 - member
+
403
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404
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METHOD FOR THE FUNCTION MONITORING OF A MOTOR VEHICLE GEARBOX AND MOTOR VEHICLE FOR USE WITH THE METHOD

The present invention relates to a method for monitoring the functions of a gearbox which is provided in a motor vehicle driven by a drive motor, preferably an internal combustion engine, in order to change the translation ratio between the output shaft of this drive motor and the driven wheels of this motor vehicle. These gearboxes include inter alia those gearwheel drives where the ratio is changed by bringing different pairs of gearwheels into engagement with each other or with a drive or output shaft, so-called automatic gearboxes which as a rule have one or more planetary wheel sets and as a rule are coupled to a hydrodynamic converter wherein the ratio change here is carried out by braking or releasing different elements of this automatic gearbox and continuously variable transmissions such as for example contact loop gearboxes wherein the change of speed is produced by for example changing the position of a cone wheel in relation to another cone wheel. Continuously variable transmissions can also be a cone pulley belt contact gearbox. With transmissions of this kind a contact loop means is provided drive-wise between two sets of cone pulleys wherein the active radius or running radius of the contact loop in relation to the sets of cone pulleys can be changed. A common factor of all these transmissions is that the position of at least one element mounted in the gearbox must be changed in order to produce a change of ratio. The invention further relates to a motor vehicle which is intended for use of this method.

The correct function of the gearbox is dependent on whether this position-variable gearbox element is brought into the correct position during a change of ratio. If the correct position is not reached then a faulty functioning of the

gearbox occurs which can lead to unexpected driving situations which might possibly not be able to be handled by the driver or can lead to damage to the gearbox.

Such a faulty functioning of the gearbox is particularly critical when automated or substantially automated control processes arise in the vehicle which are impaired by such faulty functioning since the ability of the user to react to a faulty functioning is here further restricted.

The object of the invention is to provide a method for monitoring a gearbox and a motor vehicle suitable for carrying out the method which despite simple construction and running allow a reliable monitoring of the gearbox with at least one position-variable gearbox element. This monitoring can be carried out for example when bringing into operation or after a workshop stay following repair to the gearbox component wherein the data of the gearbox is thereby stored inside a memory of a micro processor. During operation of the gearbox this data is then used to detect the engaged gear or the actual gear position.

Furthermore the object of the invention is to provide a method by means of which reference values are determined which can later be used in the area of the gearbox or of a vehicle.

Furthermore a gearbox is to be provided in a simple cost-effective way, and a method is to be produced which improve on the prior art.

This is achieved according to the invention through the subject of claim 1. It is advantageous if at least some of the following method steps are carried out:

detection of the output signal of the sensor device

through the computer unit in a first starting position,

storing of the position data value, derived from this output signal, for the first position in the memory device,

operation of an operating element connected to this position-variable gearbox element in order to bring this position-variable gearbox element as close as possible to at least a predetermined target position,

deduction of the output signal of the sensor device in the changed position through this computer unit and determination of a position data value representative of this position,

storage of the position data value in the memory device,

judgment of the position data value according to a predetermined assessment criterion through the computer unit,

repetition of the process or at least some individual process steps until this predetermined assessment criterion is reached.

The repetition can be carried out for example so that a gear is engaged which corresponds to the starting position or which is not the starting position. It is then shifted into a gear which corresponds to the target position or into another gear.

The motor vehicle according to the invention is the subject of claim 62.

This relates to a motor vehicle with a drive motor, transmission, which has at least one position-variable gearbox element whose position change causes a change in the gear ratio, a clutch device mounted between the gearbox and drive motor, a sensor device which has at least one sensor of a program-controlled computer unit with at least one processor unit which processes the signals of this sensor device, a memory device with at least one memory chip for storing data, wherein the sensor device is provided to produce a signal which changes in dependence on the position of same at least one position-variable gearbox element, that the data memory is provided to store position data values for predetermined target positions of this position-variable gearbox element, that this computer unit is provided to check the position data values stored in this data memory for an assessment criterion produced for each target position and to check whether the position of this position-variable gearbox element is sufficient to meet this assessment criterion. A signal is thereby produced which corresponds to a gear position of a gearbox element wherein the gearbox element can be operated manually by a handle, such as a shift lever, or can be operated or positioned automatically by an actor. By monitoring the position data it is possible to detect the actual gearbox position of the gearbox element and substantially at any time to monitor the actual gear setting.

The method according to the invention makes it possible to monitor the position of the position-variable gearbox element and thus the function of the gearbox in a reliable manner.

With the gearbox manufactured according to the usual series production standard the position which a position-variable gearbox element occupies and which corresponds to a specific predetermined function is not accurately known. This is due

to the fact that the tolerances of the individual elements of such a gearbox can add up in different ways so that fixing a specific position using design features can be liable to error. If this error is accepted then there is the danger that when operating the position-variable gearbox element the desired position is not reached which leads to faulty functioning.

The position-variable gearbox element is preferably a gearbox element which takes part in the torque transfer of the gearbox. If the gearbox element is not located in the correct and desired position then the torque transfer overall can be interrupted. Thereby dangerous driving situations arise since the driver will as a rule be surprised by this condition. Furthermore there is the problem that in this state there is torque introduced into the gearbox both from the drive side and also from the output side so that movements which are not desired, such as chattering of the synchronizer sleeve, can arise which can damage or destroy the position-variable gearbox element and further component parts of the gearbox.

If the torque transfer is not interrupted by the faulty functioning of the gearbox element, which is the case for example with a continuously variable transmission, then a false positioning gives rise to a false speed which leads at least to a severe jerk in the drive train which on the one hand can be perceived by the driver as unacceptable and on the other hand can also in turn lead to undesired driving situations and to damage. Through the instruction according to the invention it is ensured that the torque transfer is only carried out when the position-variable gearbox element is located in the correct position or it is detected that the gearbox element is located in the correct position. Otherwise this would be detected and indicated and in such a case a control apparatus cannot control any torque

transferable by the clutch. The risks mentioned above are thereby completely and reliably avoided. The risk which arises when a position-variable element is not in its proposed position or is not brought into this position, such as for example a gear wheel which is not completely tracked, can be made noticeable through damage. In the event of an incomplete tracking of the gearwheels or teething the full moment is only transferred in a partial area of the teething. Damages can thereby occur.

According to the invention a sensor device is provided which produces a signal which changes at least one position-variable gearbox element in dependence on the position of the signal.

As sensor device can be considered for example electrical sensors which measure a change of an electrical resistance, an inductance or a capacitance wherein the change of these electrical values is in connection with the position change of the gearbox element. There is thus a transmitter used which consists of at least two parts wherein one part of the transmitter is in active connection with the position-variable gearbox element and the other part of the transmitter is fixed relative to the component in relation to which the position is to be set. This component part is normally the gearbox housing or similar but it can however also be a second part whose position is itself likewise variable inside the gearbox but in relation to which the position is to be fixed relative to the position-variable gearbox element.

In addition to the said inductive, capacitative and resistance transmitters where ultimately a change of path is converted into a change of the electrical field or electrical resistance, sensor devices can also be considered where the position change is measured over a physical value

influenced by the path. This can be for example an elastic element which is deformed through the position change of the gearbox element and wherein the deformation is detected through force measurement or expansion measurement. A sensor device of this kind can contain for example a spring which is deformed by the movement of the position-variable gearbox element whereby a reaction force of the spring is produced which can be detected for example through a piezoelectric transmitter or through another force measuring device.

It is furthermore possible to use optical transmitters, thus transmitters where according to the interference process or the like a change of path is detected.

A further possibility for determining the change of position is the use of a sensor device which fixes digital results which means that depending on the extent of movement a number of impulses is produced which is dependent on the path stretch whereby the impulses are counted by a corresponding counter. The impulses can be produced and fixed by optical or electrical or opto-electrical devices.

The position change of the gearbox element cannot only lie in a displacement along a predetermined path, this means a one-dimensional path change, but it can also be two or three dimensional. With a two-dimensional position change, ie taking place in one plane, two sensor devices of the aforementioned kind are used accordingly wherein the sensors for determining the movement change in an assumed x- or y-direction, starting from a cathetic coordinate system, can be combined in suitable manner. With a spatial position change three sensor signals are required accordingly which can be produced by three isolated or again combined transmitters.

In addition to the one, two and three-dimensional position change the position-variable gearbox element or an element in active connection with this gearbox element can be provided so that a rotation takes place about a fixed or likewise position-variable rotary axis. In this case the sensor device is designed so that the angular change of the gearbox element or of the element connected therewith is detected. All the aforesaid methods can be considered, thus in particular the use of an inductive, capacitative or resistance transmitter as well as also again an impulse counting method with electrical and electro-optical processes. A rotary movement about a rotary axis can however also be regarded as a single-dimensional movement. A rotary movement about an axis and an axial movement along the axis can also be regarded as two-dimensional movement.

Independently of the design of the sensor device the sensor device or the received signal is processed or converted so that an in particular electrical signal is obtained which is influenced in any way by the position of this position-variable gearbox element. If this signal is an analogue signal then it can preferably be converted in a digitalizing device into a digital signal.

Furthermore according to the invention at least one computer unit is provided. This computer device can be a computer unit which is mounted in the vehicle in which this gearbox is also provided. The computer device can thereby be a device which executes only the function according to the invention. The computer device can however also be part of a central computer device of each vehicle which also executes other functions. The computer unit is particularly advantageously combined with a computer unit in the vehicle which carries out control tasks in the area of the vehicle drive. This can also be a computer device which undertakes the engine control, a computer device which carries out the

gearbox control or a computer device which carries out the control of an automatic clutch. The computer can also combine all or some of the aforementioned functions together.

According to an alternative embodiment of the invention a computer unit is provided which is mounted outside of the vehicle. This computer unit can be a computer unit at the production point of the vehicle or can be a computer unit which is provided in a workshop for maintenance of the corresponding vehicle or gearbox. The external computer unit can be combined with the aforesaid computer units inside the vehicle, or can monitor or assist their functions.

According to the invention an operating element connected to the gearbox element is operated in order to bring the gearbox element as close as possible or completely into at least one predetermined position, the target position. The operating element can be for example a selector fork, a shift rod, a shift lever connected to a shift rod or an element operated by fluid pressure and in active connection with the position-variable gearbox element.

The desired position is preferably but not exclusively a position which is characterised by certain properties. With a conventional shift transmission this can be a position where a certain gear is engaged. With an automatic transmission this can be a position which corresponds to the shifting of a certain element where a certain element of the automatic transmission is either completely blocked or completely released. With an infinitely variable transmission this can be the position which corresponds to the largest or to the smallest ratio or a certain intermediate translation ratio.

After the operating process is completed the output signal of the sensor device is detected and supplied to the at least one computer unit which derives from this a position data value which defines the position in a one or two or three dimensional reference system which also takes into account the turning angle.

The computer unit evaluates this position data value according to a predetermined assessment criterion.

The assessment criterion can contain the comparison of comparison values which are stored in a memory device. Furthermore the assessment criterion can be a computer process which runs according to a predetermined program in the computer unit and through which the position data is processed and assessed in a predetermined manner. It is furthermore possible that the assessment criterion is obtained by a method which is only started at the end of this operating process.

The solution according to the invention has a whole row of significant advantages:

Through the method according to the invention it is possible to reliably detect the position of the gearbox element independently of all manufacturing tolerances. Faulty functions of the gearbox through a false positioning of the gearbox element or through a not quite accurate positioning are thus excluded.

A special advantage of the instruction according to the invention lies in the fact that a large amount of play is produced for the arrangement of the sensor device. Since the influence of the manufacturing tolerances is removed through the invention the sensor device can also be mounted remote from the position-variable gearbox element. In

actual fact the sensor device can be provided on all elements which are connected to the position-variable element completely or substantially play-free or in consideration of play in that they take part in the movement of the position-variable element or with which any possibly arising play is directed so that it in a defined position has substantially no influence on the position of the position-variable gearbox element. Consideration of a certain amount of play is possible throughout.

Thus the invention makes it possible to mount the sensor device also outside of the actual gearbox housing provided that an operating element is provided which operates from outside the position-variable gearbox element located inside the gearbox housing.

With a shift gearing of the conventional kind the sensor device can thus be mounted for example on the shift rod or on the shift lever. Thus the sensor device can be kept completely out of the gearbox housing and is not exposed to the conditions prevailing regarding the oil atmosphere, temperature etc. Furthermore no steps have to be taken to pass the electrical signals from the sensor device out of the gearbox housing.

According to a first embodiment of the method according to the invention the assessment criterion is stored substantially unchangeable in the computer unit. The assessment criterion is then derived for example from the design details of the gearbox and is no longer changed on the constructed gearbox.

According to a preferred embodiment of the invention the assessment criterion is however changeable. With this design first a learning mode can be carried out wherein the or each position-variable gearbox element is brought into at

least some or even all provided target positions and each time the fulfilling of the assessment criterion is checked. The position data values sufficient for this criterion are stored as position reference values in the memory device. The process is then continued in a normal operating mode in which the assessment criterion contains a comparison between the actual position data values and the stored position reference values. Through this process, when operating the vehicle, reaching the relevant target position can be controlled very rapidly and reliably.

The motor vehicle according to the invention is provided with a gearbox in which the monitoring process according to the invention is used.

According to a preferred further embodiment of the invention the motor vehicle is provided with an automatically controlled clutch device. Through the monitoring of the position change the clutch can be closed as soon as the position variable gearbox has reached a predetermined position. This predetermined position which in this case is then the target position need not be the position which corresponds for example with a shift gearing to the completely engaged position. It is thus possible to close the clutch already at a time before the actual process of the position change is completed ie in the case of an example the shifting from one gear to another. In this way not only is the security of the vehicle increased in that faulty functioning of the gearbox, any possible gearbox control and any possible clutch control are avoided but the security is also further increased in that with an automatically controlled clutch the time interval which is required to open the clutch during the position change of the position-variable gearbox element or to reduce its torque-transferring function, is minimized. Thus for example with an overtaking position the drive power after a

shift process is available very much earlier than would be the case when a corresponding monitoring were not carried out.

Further features, advantages and possibilities for use of the present invention are apparent from the following description of embodiments in connection with the drawings in which:

Figure 1	is a diagrammatic illustration of a shift gear for explaining various embodiments of the invention;
Figure 2	is a diagrammatic plan view of the synchronizer sleeve and the shift teeth of the gearbox according to Figure 1;
Figure 3	is an illustration according to Figure 2 with fully engaged shift teeth;
Figure 4	is an illustration according to Figure 2 in a special position;
Figure 5	is an illustration according to Figure 2 with a special position of the shift teething;
Figure 6	is an illustration similar to Figure 2 for characterizing the length measurement;
Figure 6a	is a sketch for explaining the characterising of a special point during the shift process;
Figure 7	is an illustration similar to Figure 2 for explaining a further embodiment;
Figure 8	is a diagrammatic illustration of a continuously variable transmission;
Figures 9a,b,c,d	are diagrammatic views for explaining various embodiments of the sensor device;
Figure 10	is a diagrammatic block circuit diagram of an embodiment of the motor vehicle according

to the invention;

Figure 11 is a flow chart.

The invention will now be described with reference to individual embodiments. In order to limit the area the different combination possibilities of the features of the embodiments are not explained individually. It is however pointed out that the features of the various embodiments can be combined together. Combination possibilities are also apparent from the wordings and references of the sub-claims. The invention will first be described for a group of embodiments where a conventional transmission is used.

By the term transmission is meant gearboxes where an input speed is translated through intermeshing gearwheel gears to an output speed. The ratio between the input speed and output speed is thereby changeable in stages. Included in the transmissions mentioned here are also co-axial and non co-axial synchronizer sleeve gears, sliding gears, shift dog gears, V-belt gears and the like. For reasons of simplification the following embodiments refer to synchronizer sleeve gears which however should not be regarded as a restriction of the use of the invention in the case of transmissions.

Figure 1 shows diagrammatically a shift transmission. A drive machine (not shown), such as Otto or diesel engine drives a shaft 1 which is connected to a flywheel 2. Inside the flywheel 2 is a single disc dry clutch 3. The rotary movement of the single-disc dry clutch 3 is transferred to the gearbox housing 5 through a gearbox input shaft 4. The gear input shaft 4 is mounted in a gearbox housing through conventional rolling bearings 6, 7. The torque transfer system can be formed as a single-disc dry clutch such as a friction clutch. Furthermore the torque transfer system can be formed as a multi-plate clutch, magnetic powder clutch or

as a converter bridging clutch of a hydrodynamic torque converter.

A first gearwheel 11 with inclined teeth as well as a second gearwheel 12 with inclined teeth are mounted on the input shaft 4.

The gear output shaft 15 is likewise mounted in the gearbox housing 8 through conventional rolling bearings 16, 17 and has a first gearwheel 18 and second gearwheel 19 wherein these two gearwheels are permanently in engagement with the relevant gearwheels 11 and 12.

The gearwheels 18 and 19 are mounted loosely rotatable on the gear output shaft 15.

A synchronizer sleeve 20 is located between the two gearwheels and is operated by a shift rod 21. The synchronizer sleeve has a notched gearing directed towards the shaft 15 to engage with a corresponding notched gearing 24 on the shaft 15. The synchronizer sleeve 20 is thus always connected rotationally secured to the shaft 15 but can be displaced in the longitudinal direction towards the shaft. The synchronizer sleeve 20 is thus in this gearbox design a position-variable gearbox element. Shift teeth 22, 23 are mounted on each of the two gearwheels 18,19 to provide a rotationally secured connection between the synchronizer sleeve 20 and the relevant gearwheel.

The synchronizer sleeve 20 consists of a substantially cylindrical ring 30 which is not shown completely in the plan view according to Figures 2 to 5 and which has a notched gearing (not shown) through which it is connected rotationally secured to the shaft 15. Either side of the cylindrical ring 30 are the shift teeth 31, 32 wherein the arrangement is symmetrical in this embodiment. However a

non-symmetrical arrangement can also be provided instead of this symmetrical arrangement.

The shift teeth 31, 32 are substantially rhomboid-shaped in plan view, and have, starting from the cylindrical ring 30 two diverging rear flanks 33, 34, that is their spacing increases with increasing distance from the ring 30.

These rear flanks 33, 34 are adjoined by two front flanks 37, 38 which converge towards the common line of symmetry of the opposite flanks and meet in a point 39.

The teeth 42 of the shift gearwheels 18, 19 are correspondingly substantially rhomboid in shape in plan view and likewise have diverging rear flanks 43 and 44 as well as front converging flanks 47, 48 which converge into a point 49.

The aim of the shift process with a transmission of this kind is as shown in Figure 3 to bring the synchronizer sleeve 20 into engagement with the shift teeth 22 or the shift teeth 23 of the gearwheels 18, 19. Figure 3 shows how a completely closed shift process appears. The synchronizer sleeve 20 has been removed from the neutral position by the distance l_1 (Figure 2) and the teeth 31 of the synchronizer sleeve are located completely in engagement with the teeth 43 of the shift gearing on the gearwheel. As soon as the torque is transferred the flanks of the shift teeth adjoin one another and the gearwheel, sliding sleeve and shaft rotate with the same speed and thereby transfer the torque.

When changing gear however the state occurs which is shown in Figure 4, namely that the tip 39 of the teeth 31 during displacement strikes exactly on the tip 49 of the teeth 43. If in this position the clutch 3 is closed torque is transferred by the drive motor through the shaft 4, the

teeth 11 and 24. The shaft 15 and synchronizer sleeve 20 are connected to the wheels of the vehicle. Since as a result of the lack of tooth engagement no torque transfer can take place then the drive motor is without load and accelerates. The tips of the teeth 31, 43 thereby rattle on each other which leads to damage to the synchronizer sleeve and shift gearing. If such a shift process takes place for example during an overtaking manoeuvre then the driver no longer has any drive power during this manoeuvre so that extremely dangerous situations can arise.

Another situation is shown in Figure 5. Here the synchronizer sleeve is moved a small amount into the shift teeth. As a result of a machining inaccuracy or as a result of a surface change of one of the teeth which has occurred during operation the front flanks of the teeth of the synchronizer sleeve are prevented from sliding along the front flanks of the teeth of the shift gearing. The synchronizer sleeve then remains in the position shown in Figure 5. Also in this case as soon as the clutch 3 is closed a chattering movement of the synchronizer sleeve and shift teeth takes place wherein the synchronizer sleeve is here pressed back by the inclines of the front flanks into the neutral position. Also here therefore it is not only possible that the gearbox becomes damaged but also that dangerous driving situations may occur since in this case no torque transfer can take place.

Several embodiments of the invention will now be described through which such a situation can be prevented.

In general there are two different methods of operation which are possible with all the embodiments described below.

With a first group of embodiments the position of the position-variable gearbox element is detected, ie with the

embodiment of the synchronizer sleeve 20, and when the correct position is reached a corresponding position reference value is stored in the memory unit. With subsequent shift process the position value measured at that time is then compared with the stored position reference value.

If the difference between the actual position value and the position reference value is below a predetermined boundary value then it is accepted that the gear is engaged and a corresponding signal is issued. If the difference is however greater than this boundary value it is accepted that one of the cases described in Figure 4 or 5 exists and that therefore the shift process has not been successfully carried out.

This group of embodiments thus uses a learning process. Before bringing the vehicle into operation the corresponding reference position values are determined and stored in the memory unit. These values are then used as reference values in order to be able to always establish during the operation of the vehicle whether the position-variable gearbox element is in the correct position. A renewed learning process then preferably only takes place when work on the gearbox makes it necessary. Furthermore it can also be proposed that a new learning cycle is carried out in the workshop within the framework of regular maintenance cycles, eg every 50 000 km.

The learning process or comparison process between the stored values and the actually occurring values can be carried out for example also during operation. In this connection the actually occurring values for the corresponding gear position of the gearbox can be determined wherein this system establishes whether a gear is engaged or not. This determination can also take place through tolerance considerations.

With this group of embodiments of the invention the computer unit in the vehicle is used to compare the reference position with the actual position. The control of the position detection process itself can however also be carried out by a computer unit which is mounted outside of the vehicle. This is particularly of importance when the overall process is automated as will be described below, ie is carried out without manual operating force.

With a second group of embodiments of the invention which can likewise contain most of the following embodiments the assessment criterion is checked each time. IN this case no reference position is stored but with each shift process a check is made to see whether the relevant assessment criterion is fulfilled.

With the first embodiment it is accepted that the synchronizer sleeve is located at the start of the process in a neutral position. This neutral position can be defined for example by an engagement of the gearbox elements. Thus the synchronizer sleeve can be in any position according to a position inside the one shift gate. The starting position is identified by the core mode. This means that it can be established whether a gear or a neutral area exists as a starting position at the start of the process.

The neutral position can be learned for example from another process and the learned value of the neutral position can be entered or stored in a memory. It is thereby particularly advantageous if with the learning process the neutral position is locked. This can take place for example in that by way of example the shift lever is fixed in neutral position by a lock. Another gear can also be engaged in the gearbox and the shift lever can be fixed for example prior to being brought into operation. The fixing means can be for example a pin which ensures a fixed position of the

shift lever or of another gearbox part opposite a locally fixed component, such as body work part.

In a first method step a value corresponding to this position is fixed and stored as the starting position value by the sensor unit. With a corresponding design of the computer unit this can be for example the zero position. The synchronizer sleeve 20 is then brought by the selector shaft 21 into the position which corresponds to the illustration in Figure 3. The synchronizer sleeve must thereby cover the path l_x from the neutral position which is marked in Figure 3 by the chain-dotted line and the dash line illustration of the cylindrical ring of the synchronizer sleeve 20.

The length measurement l_x corresponds in a structural design to the nominal design l_{nenn} of the gearbox. As a result of the manufacturing and production tolerances this theoretically calculated measurement l_{nenn} which is produced from the structural design of the synchronizer sleeve and shift teeth, can only be reached with precision in few cases.

Determining the evaluation criterion will now be explained with reference to Figure 6.

In order to bring the teeth of the synchronizer sleeve and shift gearwheel so far into engagement that the transition areas from each rear flank 33 to the front flank 37 and from the rear flank 43 to the front flank 47 lie above one another, as shown in Figure 6a, the synchronizer sleeve has to be moved by the path l_1.

With an actual gearbox when determining the minimum path all tolerances of each individually designed gearbox have to be taken into consideration in relation to the movement of the

synchronizer sleeve through the shift rod.

The minimum displacement path is calculated without consideration of play as

$$l_{1,\min} = l_{1,nenn} - \sum_{i=1}^{n} \Delta t_i \,(i) \qquad (1)$$

in which

- $l_{1,\min}$ is the minimum mathematical displacement path required with the current gearbox in order to pass from the neutral position into position 1 with all possible combinations of permissible component tolerances;
- $l_{1,nenn}$ the mathematic displacement path according to the structural design taking into account the nominal measurements;
- i is a running variable for marking the component parts which influence the displacement path;
- n is the number of gearbox elements subject to tolerance which take part in the displacement or influence the displacement path;
- Δt_i is the difference between the nominal measurement of the component part i on which the design is based and the smallest tolerated value of the dimension of this component in the active direction of the length l of the displacement taking into account the sign.

When taking into account the play the equation (1) expands accordingly.

In order to slide the synchronizer sleeve into the fully engaged position 2 a displacement path l_2 is to be covered. The position 2 is thus the state wherein either the tip 39

of the synchronizer sleeve 20 strikes against the ring of the shift teeth 18 or the tip 49 of one of the teeth 43 of the shift teeth strikes against the ring 30 of the synchronizer sleeve 20 or against another stop.

With a constructed gearbox, l_2 can adopt a maximum value according to the following formula:

$$l_{2,max} = l_{2,nenn} - \sum_{i=1}^{n} \Delta t_i \,(i) \qquad (2)$$

in which:

$l_{2,max}$ is the maximum possible mathematic displacement path with the current gearbox in order to pass from neutral position to position 2

$l_{2,nenn}$ is the mathematical displacement path according to the structural design taking into account the nominal measurements;

i is a running variable for marking the component parts which influence the displacement path;

n is the number of gearbox elements subject to tolerance which take part in the displacement or influence the displacement path;

Δt_i is the difference between the nominal measurement of the component part i on which the design is based and the smallest tolerated value of the dimension of this component in the active direction of the length l of the displacement taking into account the sign.

In the same way it can be calculated how small the

displacement path can be in order to achieve an abutment between the tip and ring when all the tolerances are added up accordingly. In this case the following applies:

$$l_{2,\min} = l_{2,nenn} - \sum_{i=1}^{n} \Delta t_i \ (i) \qquad (3)$$

in which

$l_{2,\min}$ is the minimum possible mathematic displacement path with the current gearbox in order to pass from neutral position to position 2

$l_{2,nenn}$ is the mathematical displacement path according to the structural design taking into account the nominal measurements;

i is a running variable for marking the component parts which influence the displacement path;

n is the number of gearbox elements subject to tolerance which take part in the displacement or influence the displacement path;

Δt_i is the difference between the nominal measurement of the component part i on which the design is based and the largest tolerated value of the dimension of this component in the active direction of the length l of the displacement taking into account the sign.

From this it is possible to derive that the synchronizer sleeve has reached the end position when the displacement path is greater or equal to $l_{2,\min}$ and smaller or equal to $l_{2,\max}$.

When carrying out the position recognition process the computer unit first detects the output value of the sensor in a position such as the neutral position (Position 0). It can equally proceed from any other position. Then the shift rod is operated in the normal way and the output signal arising from the sensor is detected (Position 2). The computer unit calculates from the difference of the two positions the measured displacement path l_{mess}. If the measured displacement path l_{mess} is greater than $l_{2,min}$ then it can be concluded that the end position of the shift process has been reached and that the position-variable gearbox element is in the end position. This point is stored as a reference value for position 2 and the length Δl is then determined by the computer unit:

$$\Delta l = \Delta l_{nenn} - \sum_{i=1}^{n} \Delta t_i \ (i) \qquad (4)$$

in which:

Δl is the difference between the position 2 and position 1 with the current gearbox;

Δl_{nenn} is the mathematical displacement path between position 2 and position 1 according to the structural design taking into account the nominal measurements;

i is a running variable for marking the component parts which influence the displacement path;

n is the number of gearbox elements subject to tolerance which take part in the displacement or influence the displacement path;

Δt_i is the difference between the nominal measurement of the component part i on which the design is based and the smallest tolerated value of the dimension of this component in the active direction of the length l of the displacement taking into account the sign.

The sensor value belonging to Δl is stored as a reference value in the memory.

It is not necessary during operation to wait until the shift teeth have reached the end position, defined by l_2. In order to accelerate the shift process the clutch can rather then already be closed when the shift teeth have reached the position shown in Figure 6a or have been moved by a predetermined extent beyond this position. As soon as this point is reached the clutch can be closed.

Since as a result of the teaching according to the invention it can be accepted that the point l_{max} has been precisely reached under the said conditions, the length Δl can be fixed very accurately since this is still only dependent on the tolerances of the shift teeth length. Thus in this way a precise point has been reached where it is accepted that the shift process has been completed functionally correct so that the clutch can already be closed at an earlier time point.

If when detecting the sensor value for position it was left only to calculation then all the tolerances of the component parts concerned would have to be taken into consideration and a point for re-engaging the clutch would have to be defined which lies closer on the maximum displacement path than is the case with the solution according to the invention.

With a first embodiment it is assumed that the displacement takes place from a known neutral position.

With the second embodiment it is assumed that the neutral position is not known but that shift teeth are provided side by side, as is shown in Figure 1.

With this embodiment the synchronizer sleeve is first brought into engagement with the teeth 22 of the gearwheel 18 and then with the shift teeth 23 of the gear wheel 19.

In this case the sensor output signals are detected in two positions, namely in position of the engagement with the shift teeth 22 (Position 1) and of the engagement with the shift teeth 23 (Position 2). From the difference of the two positions a displacement path l_2 is produced, as shown in Figure 7. This displacement path l is assessed to see whether it is greater than a minimum value wherein in this case the following applies

$$l_{2,\min} = l_{2,nenn} - \sum_{i=1}^{n} \Delta t_i(i) \qquad (5)$$

in which

$l_{2,\min}$ is the displacement path between position 1 and position 2 in the current gearbox

$l_{2,\,nenn}$ is the displacement path between position 1 and position 2 with the structural design taking into account the nominal measurements;

i is a running variable for marking the component parts which influence the displacement path;

n is the number of gearbox elements subject to

tolerance which take part in the displacement;

Δt_i is the difference between the nominal measurement of the component part *i* on which the design is based and the largest tolerated value of the dimension of this component in the active direction of the length *l* of the displacement taking into account the sign.

If the displacement path *l* is greater or equal to the calculated minimum displacement path it is accepted that the first and second position were the relevant end positions. If the displacement path is less it is accepted that a contact tip to tip or a contact of the front flanks with each other has taken place. In this case the measurement is repeated whereby it is ensured that the gearbox wheels cannot rotate relative to each other. Measuring is repeated until the corresponding value has been reached for l_2.

Through this process the end points of the movement of the synchronizer sleeve opposite the two shift teething are known as position reference values. From these end points an engagement point is then defined each time in the same way as with the first embodiment and has a spacing Δl from the relevant end positions and defines the position from which the clutch can be closed. This position or the associated sensor values are preferably likewise stored as reference position values in the memory.

With the third embodiment the displacement path during the learning process is not compared with a calculated value. Rather a number of shift processes are carried out whereby it is ensured that the gearwheels can turn independently of each other between the shift operations. The end positions each time measured with the sensor device during the individual shift processes are stored. The maximum values

are determined from the individual measured values for the end positions. If a sufficiently high number of shift processes has been carried out then it can be accepted that at least with one shift process the maximum position, ie the position with a fully engaged synchronizer sleeve has been reached. The maximum values can thereby be regarded as positions of complete engagement and stored accordingly.

With this method it is assumed that a continual path or angle measurement is carried out on a component which is connected kinematically with the sliding sleeve of a shift gear or a sliding gearwheel. First a gear is engaged and the sensor value is memorized. Then another gear is engaged or shifted. The teeth in which the moved shift teeth are to engage must thereby be coupled together kinematically, for example in a manner so that the two gearwheels act on the toothed wheels of the gear input shaft. Through the different divisions of the shift teeth it is very likely that during shifting the sliding sleeves and/or slide wheel and the opposing shift teeth turn slightly relative to each other. This rotation ensures that any unfavourable position of the teeth of the gearing pair which might possibly previously exist (here, for example, tip to tip position) no longer exists. Then again the first gear is engaged and the then existing sensor value is compared with the first sensor value. If larger values are interpreted as "gearing further spared" then the following possibilities and associated evaluations are carried out.

1) The first sensor value is greater than the second sensor value plus ϵ (sensor value 1 >(sensor value 2+ϵ)).

This combination of sensor values can mean that with a first shift process or engaging gear, the gear was engaged and during a second shift process for example a condition "tip to tip" has arisen. In this case the first sensor value

marks the engaged gear.

2) The first sensor value is smaller than the second sensor value minus ϵ (sensor value 1 < (sensor value 2-ϵ).

This combination of sensor values can be interpreted so that during a second shift process the gear is engaged and during the first shift process the gear is not or exists in the "tip-tip" state. In this case the second sensor value is used as a final value for the engaged gear.

3) In other cases the gear was engaged in both cases and both sensor values mark the engaged gear.

With the above cases ϵ designates a difference to be fixed which corresponds to the sensor signal change over the length left (minus any possible play and mass tolerances). The third case can also include to an improbably low extent also double "tip-tip" states where both times a gear is not engaged. Furthermore it is also possible to engage a gear more frequently than twice and/or to engage various gears in the meanwhile.

A possible shift sequence for checking all the gears can be carried out as follows by way of example:

1-2-1-2-3-4-3-4-5-R-5-R or
1-2-1-3-2-4-3-4-5-R-5-4-R.

Thereby each gear is engaged at least twice. A change can similarly be carried out through gates.

Furthermore any combinations of the gear sequence are possible wherein each gear is engaged at least twice.

A further possibility of turning the gearwheels and/or shift

teeth between the multi-channel engagement of a gear for checking the rest position is, with the engine running, to engage the neutral gear between the two shift processes and to allow the clutch to slip or close at least in part. Through the engine rotation a gear shaft or the gearwheels are turned.

It can likewise be expedient to move the gear output shaft such as for example by rotation of the drive wheels. This can take place manually or mechanically such as automatically.

Similarly discrete sensors can be used which are adapted once when being brought into operation.

This process is based on the premise that the engagement tip-tip or contact only in the front part of the flanks is a relatively unlikely occurrence. If the positioning of the gearbox element is repeated more often and care is taken that the engagement conditions change then it is very unlikely that these occurrences are repeated. Thus after a predetermined number of shift processes have been carried out it can be assumed that the possible end positions have been reached. From these measured end positions it is also possible to determine positions where the clutch can be closed when they are reached. The predetermined number is preferably at least 2.

With the fourth embodiment the torque which is introduced into the gearbox is monitored.

For this it is possible to use when the gearbox is mounted in the vehicle at this time the engine which is mounted in the vehicle. The engine is operated at idling ie with the opened clutch and with the synchronizer sleeve in neutral position. The shift rod 21 is then operated and the gear is

engaged. As soon as the gear is engaged the clutch is closed. This preferably takes place path-controlled, that is the clutch can not only be moved between the completely opened and completely closed position but also intermediate positions can be achieved. Clutch controls of this kind are incorporated for example in automatic clutch systems.

When the gear is engaged and the clutch has overcome the so-called engagement point torque is transferred to the drive wheels. This torque rise is detected in a suitable manner and thus establishes that the gear is correctly engaged. If the gear is not engaged then there is no rise in torque.

The torque rise can be detected through the engine control or through a suitable transmitter at the engine output shaft or in the clutch area. In order to prevent damage to the drive as soon as the rise in torque has been detected the clutch is again released.

The output signals of the sensor device detected at the moment of the torque rise are stored as reference position values in the memory device and during the operation the sensor position values actually measured are then each compared with these reference values.

The fifth embodiment variation operates in a similar way to the fourth embodiment. Whereas however a rise in torque is established there with the fifth embodiment a drop in speed is determined as the assessment criterion. Also here the drive motor provided in the vehicle is preferably used to drive the gearwheels through the clutch 3 and the input shaft of the gearbox. The synchronizer sleeve is operated by the selector shaft and produces the engagement between the teeth of the synchronizer sleeve and shift teeth. The clutch is preferably closed path-controlled and it is established when the speed of the motor drops as a result of

closing the clutch.

With the fourth and fifth embodiments there is the danger that with insufficient engagement of the gear a chattering movement occurs. In order to be able to stop this as quickly as possible a vibration transmitter or position sensor can be provided on the gearbox or close to same, preferably only for the process of the first position detection to detect the vibrations in the gearbox directly or the sonic waves controlled by the gearbox and to produce an end to the attempt by returning the selector shaft back to neutral position or by opening the clutch as soon as the chattering vibrations or chattering noise have been detected. The position sensor can likewise detect vibrations which can be processed as signals from a control unit.

Modifications of the embodiments previously described.

With the 4th and 5th embodiments previously described it was assumed that the gearbox is installed in the vehicle and is operated by the drive motor installed in the vehicle. A suitable procedure is also possible in the case of the 1st to 3rd embodiments.

The design with the gearbox installed in the vehicle has the advantage that a sensor device can be used which fixes the position of the operating element in relation to the vehicle and not directly in relation to the gearbox. The sensor device can thus be mounted for example directly on the shift lever operated by the user.

It is however likewise possible to use the aforesaid embodiments prior to installation of the gearbox in the vehicle. In this case the sensor device must however detect the position of the operating element, thus for example of

the shift rod in relation to the gearbox housing. The procedure here is preferably such that a memory chip which is specific for the gearbox is provided which is set for example in the gearbox housing or which is integrated in a corresponding reading device then provided in the vehicle or whose data is transferred into the memory device provided in the vehicle and in which the corresponding position reference values are stored. It is then possible to carry out the learning processes of the embodiments described on a test stand after production of the gearbox and prior to installation of the gearbox in the vehicle and only then to install the gearbox into the vehicle. This has the advantage that the expense can be reduced during assembly of the vehicle. Furthermore it is possible with this modification to exchange a gearbox in the workshop without having to carry out the learning process again. With a further modification which is of particular advantage in the case of the 4th and 5th embodiments the learning process is carried out with the installed gearbox but rotary movement of the drive wheels is left. With this embodiment the vehicle then stands for example on a rolling test stand. Thus both active and passive implementation of the learning process can be produced.

With the active implementation of the learning process the engine mounted in the vehicle is operated in order to drive the gearbox. With an engaged clutch the drive wheels are operated through the gearbox. The speed of the drive wheels is detected in a suitable way. This can take palace for example through wheel speed sensors mounted in the vehicle which are required anyhow in the case of a vehicle fitted with an anti-slip control. When the vehicle is set up on rollers the speed can however also be detected directly by the rollers.

Particularly in the case of the last variation where the

vehicle stands on rollers it is also possible to brake the rollers so that through the drive wheels a torque is applied to the rollers and is then detected in suitable manner.

With this modification it can thus be established during the shift process which speed and where applicable which torque is applied by the engine. If at the same time the speed of the drive motor is also detected then the relevant translation ratio can also be determined so that from the measuring results it is possible to determine not only whether the position-variable gearbox element is located in a predetermined position but also which ratio has been reached in this position.

Apart from the active method a passive method can also be used wherein the vehicle engine is stationary. In this case the rotary movement is applied through the drive wheels to the gearbox and it is established in the same way as with the aforesaid 4th and 5th embodiments when a drop in speed or a rise of the torque transferred by the foreign drive has taken place.

The embodiments described above and variations were all described in relation to the use in shift transmissions.

A corresponding use is also possible in continuously variable transmissions.

Figure 8 shows a part of the continuously variable transmission as is used in motor vehicles. The gearbox illustrated is a loop contact gearbox of which for reasons of clarity only a part is shown. The loop contact gearbox has a first pair of discs with two discs 101, 102 which are mounted coaxial relative to each other as well as a second pair of discs with discs 111 and 112.

The two pairs of discs are connected together by a loop contact means 105 which can be a belt made of plastics or similar material, a metal strip, a corresponding chain or the like.

The contact loop means is somewhat trapezoidal in cross-section wherein the side edges 106, 107 run on correspondingly formed inclined edges 108, 109 of the upper pair of discs and 115, 116 of the lower pair of discs.

If the distance of the pair of discs 101, 102, 108 and 109 is changed then the position of the contact loop means 105 and thus also of the active radius changes for transferring the torque.

The change in distance is caused for example by fixing the disc 101 and moving the disc 102 through suitable mechanical or hydraulic device in the direction of arrow 120.

With this embodiment the disc 102 is the position-variable gearbox element. This position-variable gearbox element is connected to an operating element which in turn is connected to a sensor device which detects the position of the operating element.

The 1st and 2nd embodiments used previously for the shift transmission are advantageously used for fixing the position of the position-variable gearbox element 102.

With the first embodiment the operating element can be brought into one predetermined neutral position or another position and from this position preferably the two extreme positions can be started wherein the position 1 defines the position with the smallest ratio and position 2 defines the position with the largest ratio. These positions are stored in the memory as position reference values. The

intermediate values can then be detected by moving the disc by the corresponding amount from neutral position wherein the difference in the stretch between the neutral position and each relevant extreme position serves as the reference value.

As an alternative the 2nd embodiment can also be used according to which the position-variable gearbox element is first moved into position 1 and then into position 2 and the sensor values are then each stored as reference values. One of the two positions is used as the starting position and the desired displacement path is defined in relation to the overall stretch between these two positions and added to the position reference value selected as the reference point.

It is furthermore possible with this design to detect, instead of the extreme positions or even in addition to same, intermediate positions wherein in this case the drive motor of the vehicle likewise preferably serves to drive the gearbox. The output speed of the gearbox is then detected through a suitable speed transmitter, again eg through the ABS sensors or through a speed measuring device which is brought in connection with the gear output shaft or a wheel driven by the gearbox. The measured ratio values are then stored in the memory device in relation to the values of the sensor device detected each time simultaneously so that the relation between the ratio and sensor device can be fixed for the gearbox actually constructed.

Instead of the infinite transmission with contact loop gearing illustrated here other types of continuously translating transmissions can also be used, such as for example toroidal gearing, cone rolling gearing and the like. Furthermore it is possible that the gearbox is combined with a gearwheel gearing, with parallel shafts or with planetary wheel sets.

The invention was already described in relation to a conventional shift transmission and in relation to a continuously translating transmission. The invention can also be used in automatic, semi-automatic or shift transmissions which operate with planetary wheel sets. With a typical automatic gearbox such as is inserted in motor vehicles as a rule two planetary wheel sets are provided wherein an inner central wheel, ie a sun wheel normally designed as a pinion, a planetary support with two or three planets, as well as an outer central wheel, normally designed as hollow teething, are provided. Changing the translation ratio is carried out by blocking or releasing the rotation of the various elements.

Braking and releasing the individual elements is carried out for example by corresponding brake devices which are moved from first position where they do not obstruct the movement of the element into a second position where they block the movement of the element. In order to operate the brake devices operating devices are provided which are operated hydraulically for example.

Also here according to the teaching of the invention a sensor device is provided which detects the movement of the relevant operating element. Thereby in principle all the embodiment variations described above can be used, ie the movement from a neutral position, the movement from one extreme position to another extreme position, the statistical process, as well also the variation wherein a change in the torque or speed is established.

The last two variations are particularly but not exclusively of importance if the planetary wheel sets are not provided with a hydrodynamic converter, as with such gearboxes nowadays, but with a mechanical clutch, preferably a single-disc dry clutch wherein then an automatically operated

clutch is preferably used.

The sensor device used according to the invention can be designed very differently depending on the type of transmission.

As already explained, all types of known path transmitters can be used as sensor device, thus more particularly inductive, capacitative, step impulse and optical transmitters can be used. Since with a vehicle transmission as rule a higher number of gears, mostly six driving gears, including reverse gear, or more is used, the sensor device must detect the movement in several directions.

The sensor device is preferably mounted with a manual transmission in the area of the shift lever or shift rod, ie the connection between the shift lever and gearbox. Figure 9a shows the shift rod of a certain type of conventional shift transmission wherein the shift rod 200 can execute a ratio movement in the direction of the double arrow 201 and a rotational movement in the direction of the double arrow 202. In order to detect the reference positions of such a shift rod it is necessary to provide a path sensor which detects the movement in the direction of arrow 201 and a rotary angle sensor which detects the movement n the direction of arrow 202. Path and rotary angle sensors of this kind are known in the prior art and therefore need not be explained individually in further detail.

If changing gear requires the shift rod to move in two or three planes then two or three sensors are provided accordingly to detect movement in the relevant direction. Thereby for reasons of simplicity, if the structural design does not prevent otherwise, the components of movement are detected in a carthesian coordinate system and the displacement path in the plane or in space is detected from

the measured values.

Figure 9b shows in side view and Figure 9c in plan view the detection of the movement of a conventional shift lever in a two-dimensional plane.

The shift lever 210 is guided through the opening of a sensor device 211.

This sensor device has a rectangular frame 212 with two parallel longitudinal arms 213 and 214 and two short arms 215 and 216 mounted perpendicular thereto. A displacement element 220 is mounted parallel to the long arms 213, 214 which is designed so that it always moves parallel to the arms 213 and 214. At right angles to this is a displacement element 221 which is designed in a corresponding way so that it is always moved parallel to the short arms 215, 216.

A length measuring device, such as for example a step detection unit or the like is provided in one of the arms 213, 214 and in one of the arms 215, 216 to detect the position of the displacement element 221 relative to the arms 213. In a corresponding way the arm 215, 216 is fitted with a position detection device for the displacement element 220.

If the shift lever 210 is moved inside this sensor device 211 the displacement elements 220 and 221 are moved accordingly. The position change in the displacement elements is detected so that at each time point the position of the shift lever can be determined from the positions of these two displacement elements. With a sensor device of this kind it is possible to detect with accuracy the displacement of an operating element or a part of an operating element in one plane. By way of example when bringing the electronic clutch management system such as the

automated clutch, into operation, it can be expedient if a force, such as the maximum force is detected with a gear change process and from this force the threshold values are defined and fixed which are used as uncoupling thresholds during operation of the vehicle wherein with an operation of the shift lever the clutch is disengaged. If when starting operation the activation of the shift lever is too quick then with a fixed beat rate for scanning the sensors a condition occurs where the maximum force falls in a time range in which no sensor value is detected. In order to avoid this the length of the shift process can be detected and on understepping a predeterminable time length of the shift process a signal can be produced so that the shift process is carried out again and more slowly in order to detect again the value of the maximum force during the shift process.

It can likewise be advantageous if the specific value of the maximum force which is evaluated as too small because the shift process was too quick is increased by a fixed value. This value which is thus corrected can be adapted in later operation through adaption of the operating force during the shift process to the actual value.

Figure 9d shows a further embodiment of a sensor device which is suitable for detecting the position of an operating element. With the illustrated embodiment the position of the shift lever 240 is detected which is moved inside a slide guide 241. The slide guide illustrated corresponds to the conventional H-plan in shift transmissions wherein next to the H which defines the gears 1, 2, 3, 4, on the left, seen in the illustration of Figure 9d is a slide guide opening for the reverse gear into which the shift lever can preferably only be moved after first overcoming a certain resistance, and in addition on the right there is a corresponding slide guide opening which defines the position

of the shift lever for 5th gear.

Along the path of movement of the shift lever is a measurement recorder 245 which in the illustrated embodiment according to Figure 9d is provided either side of the individual slide guide openings. If the shift lever is now moved in the slide guide then this movement is recorded by the measurement recorder 245 from which then the actual position of the shift lever can be determined. As measurement recorder can be considered for example a step recorder through which the position of the shift lever is determined in relation to the predetermined zero position.

The transmitter illustrated in Figure 9d has the significant advantage that here a one-dimensional detail is sufficient to determine the position of the shift lever although the shift rod itself here carries out a translatory and a rotational movement for which a two-dimensional transmitter would actually be required to detect same.

A series of embodiments and variations have been described above which can be used for detecting the position of a position-variable element in a gearbox. Furthermore details of sensor devices were discussed with which the corresponding movement of the position-variable gearbox element is detected.

Different possibilities for operating the operating element or for releasing the movement of the operating element will now be described.

According to a first alternative the operation is carried out manually. This alternative is particularly suitable when the gearbox is already installed in the vehicle.

An operating force then occupies the position of the driver

and switches the gearbox according to the proposed variation into the relevant gears. With the first and second variations the operating force as a rule switches the gears in a predetermined sequence. The operating force is preferably informed through an acoustic or optical display or through an alpha-numerical or symbol display, whether the relevant desired position has been recognized.

If the vehicle has a display which is provided for displaying text then instructions can be sent to the operating force via this display, such as the learning process for the gearbox positions is to be implemented n detail. The entire run is then preferably controlled in the dialogue in which each next step to be carried out is provided in the display.

A corresponding procedure is also possible with the third, 3rd, 4th and 5th variations. Also here corresponding instructions can be sent to the operating force for example through a work sheet or through a display.

If an embodiment is selected where an external computer unit is used which controls the learning process alone or together with a computer unit mounted in the vehicle, acoustic signals can also be issued for example through a loudspeaker. In this case corresponding digitally coded audio signals are preferably filed in the external computer and, played analogue through a speaker, issue the corresponding instructions.

According to a second alternative the entire learning process is carried out automatically. This alternative is sufficient to carry out the learning process in a gearbox which is not installed in a vehicle. The gearbox is preferably then mounted in a test stand which depending on the chosen variation of design is connected to a drive

device and/or an output device, ie a brake device. The operating element is operated through a handling device controlled by a corresponding computer and, depending on the type of embodiment, stops at the different positions to be detected. The relevant reference values are, as described above, detected and stored so that they are available after installation of the gearbox in a vehicle.

The automatic implementation of the learning process can however also take place when the gearbox is already installed in the relevant vehicle.

In this case with a gearbox operated by a shift lever the shift lever is moved into the relevant desired positions through a corresponding handling device. Even with this design all the said variations are possible.

With the illustrated embodiments and variations, in relation to the explanation on the shift transmission it was assumed that the shift transmission is shifted by a shift lever with normal use of the vehicle by the driver.

The invention can however also be used with the illustrated embodiments and variations in the case of a shift transmission where the change of gear is carried out by an electrically, hydraulically or similarly operated aid. With a gearbox of this kind the command to change gear is indeed issued by the user, for example by operating corresponding buttons on the steering wheel or near the steering wheel on the dashboard etc, but the actual shift process is however carried out by the position-variable gearbox element being caused to change position by a secondary aid.

Also in this case all the embodiments of the invention described can be used. Since a shift lever is not provided the sensor device cannot detect the position of a shift

lever. In this case the sensor device is arranged so that it detects the position of one of the elements which takes part in changing the position of the position-variable gearbox element. This can be for example the piston of an actuator cylinder, the position of the piston rod of the cylinder, the position of a shift rod, or the position of another element which takes part in or is influenced by the transfer of movement.

The invention can furthermore also be used without alteration in shift transmissions which are shifted fully automatically. Shift transmissions of this kind are gearboxes where not only the position change of the or each position-variable gearbox element is carried out by a correspondingly controlled operating device, but where also the shift command itself is derived from the given driving situation and operating data.

From Figure 10 a preferred embodiment of the invention is now described which embodies one of the numerous combination possibilities of the individual embodiments of the invention which are apparent from the preceding description.

Figure 10 shows in block circuit diagram significant elements of a vehicle.

The motor vehicle is driven by an internal combustion engine, preferably an Otto or diesel engine 300. The output speed of the engine is transferred through a shaft 301 to a clutch device 302. This clutch device is integrated in the flywheel of the engine 300 and contains a single-disc dry clutch (not shown).

The clutch is engaged and disengaged through a disengagement lever 305 wherein the disengagement lever 305 is operated through a clutch operating device 306. The clutch operating

device has a first hydraulic cylinder (not shown) which serves as a master cylinder and which defines a predetermined engagement position of the clutch as well as a slave cylinder which takes up the pressure of the hydraulic fluid from the first hydraulic cylinder whereby a corresponding movement of the piston in the direction of the double arrow 3087 and thus also of the disengagement lever is produced. The clutch operating device 306 is controlled with precision so that the clutch can transfer predetermined torque values without slip and on exceeding this predetermined torque value slip is actuated.

The output shaft 310 of the clutch is connected to a gearbox 311. This gearbox is a conventional shift transmission which has 5 forward gears, a neutral position and a reverse gear. The shift transmission has parallel gearbox shafts on which teeth are arranged, similar to that in Figure 1, which engage with each other and which are released or blocked relative to the relevant gearbox shaft through synchronizer sleeves (not shown).

The gearbox is shifted by a shift rod 314 which is operated manually by the user by means of a shift lever 316. The shift lever is displaceable in a direction parallel to the drawing plane, as indicated by the double arrow 318, and in a direction perpendicular to the drawing plane, as indicated by double arrow 319.

The movement of the shift rod is detected through a sensor device 320. This sensor device 320 can also be mounted directly on the shift lever itself. The shift lever and the shift rod as well as the gearbox itself correspond to the type normally used nowadays in vehicles and therefore need not be described in further detail.

The gearbox 311 has an output shaft 312 which is connected

in a suitable way by one or more differentials to the drive wheel or the drive wheels of the motor vehicle.

The engine 300 is controlled by an engine management system 330 which detects the operating values of the engine and vehicle and according to a provided program determines the amount of fuel supplied per unit time or with each injection process and (in the case of an Otto engine) the optimum ignition timing as well as when present optimum valve settings.

The engine management system 330 is controlled by a program which is stored in the memory 331 in which other data is also stored.

In order to detect the operating values of the vehicle a number of sensors can be used, more particularly a lambda probe, temperature sensors for determining the temperature of the intake air, the atmospheric temperature, the cooling water temperature, the oil temperature and the exhaust gas, pressure sensors for determining the pressure in the inlet channel, the oil pressure, the pressure in the brake and other hydraulic devices of the vehicle, sensors for detecting the speeds, such as engine speed, gear output speed, wheel speeds etc, as well as sensors which can record forces and/or accelerations, eg sensors for detecting the transverse acceleration of the vehicle, length acceleration or the force acting in the wheel suspension.

The clutch operating device 306 is connected to a program-controlled clutch control device 335 which is controlled through a program stored in the memory 336 or wherein the data are also stored in this memory.

The clutch control device is connected to a shift command and issuing device 340 which is controlled by a program

which is filed in the memory 341 in which the required data are also stored.

A shift desire detection device is furthermore provided which is controlled by a program which is stored in the memory 346 in which data is also stored and a computer device 350 is provided which is controlled by a program which is filed in the memory 351 in which also operating data more particularly the position information values are also stored.

All control and computer devices are connected together by data lines (not shown).

The sensor device 320 is connected to the shift desire detection device 345 and the computer unit 350.

The function of this embodiment is as follows:

After assembly of the vehicle or after fitting the drive unit in the vehicle the computer unit 350 is first switched to a learning mode. On the display of the vehicle the instruction is given to the operating force to shift the gear, ie to engage the individual gears in a certain sequence provided by the alpha-numerical display. With each gear the computer unit 350 checks on the basis of signals issued by the sensor device using an assessment criterion stored in the memory 351 for this gear, whether the gear has been correctly engaged. If this is the case, the detected position is stored in the memory 351 as the reference position value. Instead of the reference position value however a certain boundary value derived from this value can also be stored so that when this value is exceeded this shows the engagement of the gear at a point where the clutch can be engaged.

When the learning mode is concluded the computer unit 350 is switched over to normal operating mode. This normal operating mode functions as follows:

As soon as the driver wants to change gear he operates the gear shift lever 316. The movement of the lever changes the output signal of the sensor 320. The shift desire detection unit 345 monitors this output signal and from the alteration establishes that a shift desire is present. It then causes with a corresponding control signal the command issue device 340 to issue a corresponding command to the clutch control device.

The clutch control device issues a control signal to the clutch operating device 306 which causes the clutch to be disengaged.

Through the further movement of the shift lever 316 which has meanwhile taken place the position-variable gearbox element, namely the synchronizer sleeve for the new gear has moved into the shift teeth of the relevant gear wheel. This position change is checked by the computer unit 350 using the output signal of the sensor device 320.

As soon as the assessment criterion now applying and which depends on the reference position value for this gear stage detected in the learning mode, is fulfilled then the computer unit sends a signal to the clutch control device which issues a control signal through which the clutch is again engaged. The clutch control device thereby preferably takes into account the operating data of the engine management system and more particularly the torque actually to be transferred and moves the clutch so far in the engagement direction that this torque can be reliably transferred. If according to the data of the engine management system 330 a torque of 75 Nm is to be transferred

for example, then the clutch is closed up to a value at which 85 Nm can be transferred. Alternatively the clutch can also be closed completely. The only partial closing has however the advantage that the path for further disengagement is shorter during the next shift.

The command issuing device 340 further checks from the engine data and other operating values of the vehicle, more particularly also the position of the brake pedal, which is detected by a brake pressure or brake pedal position sensor (not shown) whether the clutch device 302 is to be disengaged. This is then the case when the engine speed drops below a predetermined boundary value. Also in this case the command issuing device sends a control signal to the clutch control device in order to open the clutch.

In order to make it easier to drive off and shunt when parking the shift can be such that a low torque is transferred further so that slip arises between the engine and gearbox which leads to creeping of the vehicle.

The embodiment according to Figure 10 can be modified so that a gearbox control device 360 is provided which is controlled by a program which is stored in the memory 361 in which the required data are also stored. The gear control device 360 is connected to a gear operating device 370.

With this embodiment the shift lever 316 is omitted or the shift lever 316 is only used as an additional selector lever. The sensor 320 is in this case mounted between the gear operating device 370 and the gearbox 311.

The gear control device 360 detects from the operating data provided in the engine control 330 and from other operating values picked up by the said sensors, the need for changing the ratio of the gearbox 311. As soon as the gear has to be

shifted a corresponding command is sent to the gear operating device 370. At the same time a control signal is sent to the command issue device 340 or directly to the clutch control device 335 which causes the clutch to be opened by the clutch operating device 306. As soon as the computer unit 350 recognizes from the output signals of the sensor device 320 that the shift process has closed sufficiently a renewed control command is sent to the command issue device 341 or to the clutch control device 335 which causes the closing of the clutch through the clutch operating device 306. Also here the clutch is closed preferably so far until the transfer of a certain torque dependent on the operating values is guaranteed.

Instead of the gear control device 360 or alternatively thereto with a further modification of the embodiment according to Figure 10 the gear operating device can be connected to a shift device 372.

This shift device can be for example buttons which cause the relevant gear to shift up or down. The shift process itself is carried out in a similar way to that described above when using a gear control device. The shift device 372 can be fixed for example on the steering wheel of the motor vehicle and causes then a shifting of the gear 311 with automatic operation of the clutch.

The essential advantage of the embodiments mentioned in relation to Figure 10 is the fact that for shifting a substantially conventional gearbox is used which has no hydrodynamic converter. The loss of power and the inertia of a hydrodynamic converter is thereby avoided and the consumption of the vehicle is clearly reduced.

Irrespective of this the invention can however also be used with its various embodiments in a motor vehicle which has a

gearbox with a hydrodynamic converter connected on the input side as clutch or in addition to a clutch.

The functions of the engine control device, clutch control device, command issue device, shift desire detector device as well as computer device and where applicable gear control device can be combined into one or more control devices. The functions of the data memories can also be combined in a corresponding way in one or more data memories.

Furthermore it can be expedient if the play in the inner shift, that is with the component parts in the area of the gearbox which are operated or used during the shift process, can be adapted during the service life and where applicable are adapted. If for example play becomes increased with the appearance of wear then rest positions of the inner shift and/or outer shift can be moved with an engaged gear on the gearbox and/or on the shift lever. The outer shift is thereby the area of the shift mechanism which is outside of the gearbox. This can be for example a rod linkage, a Bowden cable connection, a pressurised medium connection or something similar and/or a shift lever.

The rest position of the outer shift can be adapted with a shifted gear on the gearbox and on the shift lever during operation by adaption to the measured positions.

It can be advantageous if such adaption is carried out when at least one of the following conditions is met:

- a gear is recognized as engaged;
- the vehicle is in the driving state;
- the speed of a shift lever movement is less than a predefinable boundary value;
- a force on the shift lever, for example detected by a difference path with a predefinable elasticity, is less than a predefinable boundary value;

- the gear is shifted in a predefinable time;
- the sign of the engine moment has been changed at least once;
- the temperature of the engine, cooling water and/or engine oil is greater than a predefinable boundary value;
- no replacement strategy is active.

The control unit initiates an adaption if for example one of the above conditions is fulfilled. The rest position on the shift lever can be carried out separately or with the adaption on the gearbox-side setting means, such as the inner shift. The adaption carried out at the same time can be produced by means of the translation of the outer shift, such as for example lever translation.

The adaption can be carried out as follows whereby a flow chart 400 is shown in Figure 11. The actual value of the rest position which is stored in the control unit and with which the control unit is operated is adapted to a measured value, for the shifted gear, once or several times. All or some of the values of the rest position are detected in a predefinable time span and from these values a calculated such as averaged value is determined for the rest position. The calculated value can then be compared with the actual value at the time and at 401 a difference is formed in order to determine the increase or drop in the play. The theoretical increase which is undertaken in the control unit is restricted to a predefinable value. The time dependence of the change is then smoothed out through a filter at 402. In this embodiment a PT1 member is provided as filter wherein another filter can also be used. At 403 the new value is then checked for observing a maximum and minimum threshold value and if the value 404 falls within the tolerance band of the threshold values is stored and used in the further control.

Furthermore a method described above or a device described above can also be used to detect the gate positions. The shift gates of the gearbox are thereby the gates in which shift elements such as the shift lever are moved in order to engage gears. As a rule there are in vehicle gearboxes at least two shift gates, often three, four or more gates.

The geometric positions of the gates are provided by the gearbox geometry of the shift slide or the arrangement of the selector forks or shift rods inside the gearbox. With an operation to determine the gate position it can advantageously arise that at least one gear is engaged, the associated gear position and/or gate position is detected and stored in the control unit. An absolute position of a shift gate can thereby be fixed and the position of other positions, such as of the remaining gates can be calculated or determined in relation to the detected gate position or detected gate positions. Taking into account the manufacturing tolerances of the gearbox it is possible to determine with the knowledge of one gate position and the relative distance from the other gates to the known gate position of the first gate an engagement of a wrong gate since the gate positions of the individual shift gates should not be intersected.

During operation with the knowledge of the absolute position of a gate position or gear position and the associated relative position of the other gates or gear positions it can be recognized if a user has shifted into a gate/gear position which is not prescribed and he can be requested through an indicator to change into the correct gate/gear position. The user can thus be asked to correct his action. This request can take place until the sensor data recognize the correct gate or gear position.

From an absolute position of a gate and with the knowledge

of the geometry of the gearbox it is possible to calculate for example by a straight line equation the remaining gate positions. If the association is not clear by using two measured gate positions it is possible to determine the remaining gate positions by means of for example a rectilinear equation. A linear connection of the gate positions and signal is thereby a prerequisite. If the connection between the gate position and sensor data is non-linear then a non-linear function can also be adopted to calculate the gate positions. It can thereby be advantageous if the gates furthest removed are started and their position determined in order to calculate from this data the intermediate gate positions.

The gate positions can also be used for calibrating the sensor, such as incremental path sensors wherein the selected gate position is set to an absolute value and the corresponding sensor value is corrected to this absolute value if deviations appear between these values.

Furthermore it is possible to learn the gates through engaging all the gears.

The operation is carried out for example by instructions through a display. The user is guided through displays and carries out the predetermined steps of the operating process wherein the individual steps can be prescribed by the display or the steps are fixed and the user obtains the time of execution through the display. Furthermore the display can also indicate the sensor data of the gearbox sensors and/or shift lever sensors and provide the user with an indication as to whether the detected and stored data lie in a predefinable value area or whether they lie outside of the predeterminable value area and the operation has to be carried out again at least in part.

The patent claims filed with the application are proposed wordings without prejudice for achieving wider patent protection. The applicant retains the right to claim further features disclosed up until now only in the description and/or drawings.

References used in the sub-claims refer to the further design of the subject of the main claim through the features of each sub-claim; they are not to be understood as dispensing with obtaining an independent subject protection for the features of the sub-claims referred to.

The subjects of these sub-claims however also form independent inventions which have a configuration independent of the subjects of the preceding sub-claims.

The invention is not restricted to the embodiment of the description. Rather numerous modifications and alterations are possible within the framework of the invention, more particularly those variations, elements and combinations and/or materials which are inventive for example through combination or modification of individual features or elements or method steps contained in the drawings and described in connection with those in the general description and embodiments and claims and lead through combinable features to a new subject or to new method steps or sequence of method steps where they relate to manufacturing, testing and work processes.

CLAIMS

1. Method for monitoring the functions of a motor vehicle transmission which has at least one position-variable gearbox element whose change in position causes a change in the gearbox ratio, through use of a sensor device which has at least one sensor which produces a signal which in dependence on this changes at least one position-variable gearbox element, a program-controlled computer unit with at least one processor unit which processes the signals of this sensor device, and a memory device with at least one memory chip for storing data which contains information which relates to at least one position of this position-variable gearbox element, with the following method steps:

detection of the output signal of the sensor device through the computer unit in a first starting position,

storing of the position data value, derived from this output signal, for the first position in the memory device,

operation of an operating element connected to this position-variable gearbox element in order to bring this position-variable gearbox element as close as possible to at least a predetermined target position,

deduction of the output signal of the sensor device in the changed position through this computer unit and determination of a position data value representative of this position,

storage of the position data value in the memory device,

assessment of the position data value according to a

predetermined assessment criterion through the computer unit,

repetition of the process or at least some individual process steps until this predetermined assessment criterion is reached

2. Method according to claim 1 characterised in that this position change contains a substantially translatory displacement of the position-variable gearbox element along a predetermined displacement path.

3. Method according to claim 2 characterised in that the displacement path is substantially linear.

4. Method according to claim 2 characterised in that the displacement direction changes during the displacement.

5. Method according to one of claims 2, 3 or 4 characterised in that this assessment criterion contains a comparison of the displacement path covered during displacement, with a predetermined boundary value and that this assessment criterion relative to the displacement path is fulfilled when the measured displacement stretch is greater than the predetermined boundary value

6. Method according to one of claims 2 to 5 characterised in that this assessment criterion contains a comparison of the displacement path covered during displacement, with a predetermined boundary value and that this assessment criterion relative to the displacement path is fulfilled when the measured displacement stretch is smaller than this predetermined value.

7. Method according to at least one of claims 1 to 6 characterised in that this position change contains a

rotation of the position-variable gearbox element.

8. Method according to claim 7 characterised in that this assessment criterion contains a comparison of the turning angle changed during the rotational movement with a predetermined boundary value and that this assessment criterion regarding the turning angle is fulfilled when the turning angle is greater than a predetermined boundary value.

9. Method according to claim 7 or 8 characterised in that this assessment criterion contains a comparison of the turning angle changed during the rotational movement with a predetermined boundary value and that this assessment criterion relative to the turning angle is fulfilled when the turning angle is less than a predetermined boundary value.

10. Method according to at least one of the preceding claims, characterised in that the computer unit receives data from a second sensor device which detects the operating values which are in connection with this gearbox and that the fulfilment of the assessment criterion is dependent on the operating data of this second sensor device.

11. Method according to claim 10 characterised in that the assessment criterion in relation to at least one operating value is fulfilled when the operating value determined as a result of the output signal of the second sensor device is greater than a predetermined boundary value.

12. Method according to claim 10 or 11 characterised in that the assessment criterion in relation to at least one operating value is fulfilled when the operating value determined as a result of the output signal of the second sensor device is less than a predetermined boundary value.

13. Method according to claim 10 characterised in that the assessment criterion in relation to at least one operating value is fulfilled when the change in this operating value within a predetermined time interval is greater or lesser than a predetermined boundary value.

14. Method according to at least one of claims 10 to 13 characterised in that this at least one operating value is derived from the operating data of an engine control which controls a drive motor connected to a gearbox.

15. Method according to at least one of claims 10 to 14 characterised in that the operating value is the torque introduced into the gearbox.

16. Method according to at least one of claims 10 to 15 characterised in that this operating value is the torque issued by the gearbox.

17. Method according to at least one of claims 10 to 16 characterised in that this operating value is the input speed of the gearbox.

18. Method according to at least one of claims 10 to 17 characterised in that this operating value is at least one output speed of the gearbox.

19. Method according to at least one of claims 10 to 18 characterised in that this operating value is the translation ratio of this gearbox.

20. Method according to at least one of claims 1 to 19 characterised in that this first sensor device has at least one sensor which is selected from a group of sensors which are provided for measuring a path stretch, a turning angle, a force, a pressure, a time.

21. Method according to claim 20 characterised in that this sensor converts a physical value into an analogue electrical signal.

22. Method according to claim 20 characterised in that this sensor detects a certain event and issues an impulse when this event has occurred.

23. Method according to claim 22 characterised in that a counting device is connected in after the sensor which detects an event.

24. Method according to at least one of claims 1 to 23 characterised in that the assessment criterion corresponding to each target position can be changed in this memory device.

25. Method according to claim 24 characterised in that the method steps according to claim 1 are repeated for each target position until a first assessment criterion provided in the memory device is fulfilled and that after fulfilling this first assessment criterion the position data values determined for this target position are stored as position reference values in this memory device and that then with each following position change reaching this target position is checked from a second assessment criterion which contains a comparison with these stored position reference values.

26. Method according to claim 25 characterised in that this second assessment criterion is stored in this memory device as a substantially unchangeable assessment criterion.

27. Method according to at least one of claims 1 to 24 characterised in that this assessment criterion is derived from a statistical method.

28. Method according to claim 27 characterised in that this position-variable gearbox element is repeatedly brought close to the relevant target position and that from this statistical analysis position-reference values are determined for this target position which are stored in this memory device as the foundation for a new assessment criterion.

29. Method according to at least one of claims 24 to 28 characterised in that this gearbox is first subjected to a learning mode in which these position-reference values are detected and stored in the memory device and that the gearbox is then operated in a normal operating mode in which the monitoring of reaching a target position is detected in which these position reference values serve as a basis for this assessment criterion.

30. Method according to claim 28 characterised in that this computer unit can be controlled so that changing over from the normal operating mode to the learning mode can be carried out.

31. Method according to at least one of claims 24 to 30 characterised in that this learning mode is carried out when the gearbox is installed in the vehicle.

32. Method according to claim 31 characterised in that at least one processor unit of this computer unit is installed in the vehicle.

33. Method according to claim 31 or 32 characterised in that at least one processor unit of this computer unit is not installed in this vehicle.

34. Method according to at least one of claims 31 to 33 characterised in that this computer unit is connected to at

least one output device which is selected from a group of output devices which comprise a terminal, alpha-numerical display, graphic display, mixed display, printer and loudspeaker and which sends instructions to an operating force.

35. Method according to at least one of claims 24 to 34 characterised in that the drive motor of the motor vehicle is used during the learning mode in order to introduce torque into the gearbox.

36. Method according to claims 10 to 34 and claim 35 characterised in that the motor and gearbox are connected by means of a clutch device and that at least one of these operating values is detected during the closing process of the clutch and is taken into consideration when fulfilling the assessment criterion.

37. Method according to claim 36 characterised in that the gearbox is in fixed connection during coupling with the drive wheels of the vehicle wherein the motor vehicle is supported so that these drive wheels can carry out a rotary movement.

38. Method according to claim 38 characterised in that the gearbox during engagement of the clutch is in fixed connection with the drive wheels of the vehicle and that these drive wheels are prevented from rotary movement.

39. Method according to at least one of claims 10 to 23 and 24 to 37 characterised in that the wheels are connected rotationally secured with the gearbox and that the wheels are driven by means of an external drive device.

40. Method according to claim 35 characterised in that the drive motor and gearbox form one structural unit and that

the learning mode is executed before this structural unit is installed in the motor vehicle.

41. Method according to claim 35 characterised in that this learning mode is executed when this gearbox is not installed in a motor vehicle.

42. Method according to at least one of claims 1 to 41 characterised in that at least one part of this memory device is mounted on or in the gearbox.

43. Method according to claim 42 characterised in that when the gearbox is installed this memory device is connected to a device mounted in the vehicle for exchanging data.

44. Method according to at least one of claims 38 to 41 characterised in that this memory device is only used during this learning mode and that when the gearbox is installed the stored data are transferred to a memory device mounted in the vehicle.

45. Method according to at least one of claims 30 to 44 characterised in that the operation of this operating element is carried out by a program-controlled handling unit.

46. Method according to at least one of claims 1 to 23 characterised in that the assessment criterion applying for each target position is substantially unchangeable.

47. Method according to claim 46 characterised in that this assessment criterion is substantially unchangeable and cannot be influenced by a learning mode.

48. Method according to at least one of claims 1 to 47 characterised in that the gearbox has a shift device and

that the position change of the position-variable gearbox element is caused by operating this shift device.

49. Method according to claim 47 or 48 characterised in that this shift device has at least one energy conversion device in which supplied electrical energy is converted into kinetic energy.

50. Method according to claim 47 or 48 characterised in that this shift device has at least one energy conversion device in which energy supplied with fluid under pressure is converted into kinetic energy.

51. Method according to claim 48 characterised in that this gearbox shift device is manually operable by the user.

52. Method according to claims 48 to 51 characterised in that the operation of this operating element is carried out by a shift lever and that this sensor device detects the movement of this shift lever.

53. Method according to at least one of claims 46 to 50 characterised in that a clutch device is provided between the drive motor and gearbox which can adopt at least two operating states, namely a first operating state where the connection between motor and gearbox is interrupted as well as a second operating state where a torque is transferred from this motor to this gearbox, that a clutch operating device is provided through which the clutch can be moved from this first to this second operating state and that this computer unit controls this clutch operating device so that the clutch operating device is only moved into the second operating state when this assessment criterion is fulfilled.

54. Method according to at least one of claims 48 to 50 and 52 or 53 characterised in that this computer unit detects

operating values of the vehicle and issues an operating command to this gearbox shift mechanism when a predetermined shift criterion is met.

55. Method according to at least one of claims 1 to 54 characterised in that this gearbox has at least four gearwheels and that this position-variable gearbox element is moved by this operating element from a first position where at least one of these gear wheels is fixed in relation to a gearbox shaft into a second position where this gearwheel is released in relation to this gearbox shaft and can rotate relative to same.

56. Method according to claim 55 characterised in that this position-variable gearbox element is a synchronizer sleeve which is fixed rotationally secured but displaceable on a gearbox shaft and which in the engaged state is connected with positive or force-locking engagement to this gearwheel.

57. Method according to claim 53 characterised in that this gearbox has at least two parallel gearbox shafts and that this synchronizer sleeve can be moved from a first position where it fixes a first gearwheel relative to the gearbox shaft into a second position where it fixes a second gearwheel relative to this gearbox shaft.

58. Method according to claim 57 characterised in that the first position corresponds to this execution position and the second position corresponds to the target position and that this assessment criterion takes into account the displacement path between this first position and this second position.

59. Method according to at least one of claims 54 to 58 characterised in that the operating element is a shift rod which is connected to this synchronizer sleeve and that this

sensor device detects the movement of this shift rod.

60. Method according to claim 55 characterised in that this gearbox has at least one planetary wheel set and that this position-variable gearbox element can be moved from a first position in which at least one gearwheel of this gearwheel set is prevented from rotary movement, into a second position where this at least one gearwheel of this gearwheel set can execute a rotary movement.

61. Method according to at least one of claims 1 to 60 characterised in that the ratio from input speed to output speed of this gearbox is infinitely variable and that this position-variable gearbox element is an element which causes the change in the ratio of this gearbox.

62. Motor vehicle with a drive motor, a transmission which has at least one position-variable gearbox element whose position change causes a change in the gear ratio, a clutch device mounted between the gearbox and drive motor, a sensor device which has at least one sensor of a program-controlled computer unit with at least one processor unit which processes the signals of this sensor device, a memory device with at least one memory chip for storing data, characterised in that the sensor device is arranged to produce a signal which changes in dependence on the position of same at least one position-variable gearbox element, that the data memory is provided to store position data values for predetermined target positions of this position-variable gearbox element, that this computer unit is provided to check the position data values stored in this data memory for an assessment criterion produced for each target position and to check whether the position of this position-variable gearbox element is sufficient to meet this assessment criterion.

63. Motor vehicle according to claim 62 characterised in that this computer unit is provided to check after each position change of the gearbox element the target position reached and to issue a control signal which causes a repeat of this operating process when the position reached by this position-variable gearbox element does not satisfy this assessment criterion.

64. Motor vehicle according to claim 62 or 63 characterised in that this computer unit can be switched over to a learning mode where for each target position position data values are stored as position reference values when the positions reached each time are sufficient for this assessment criterion.

65. Motor vehicle according to claim 64 characterised in that for each target position a first assessment criterion is provided which is used in normal operating mode which is used in the learning mode as well as a second assessment criterion wherein this second assessment criterion contains a comparison of the position reached with the reference position detected in the learning mode.

66. Motor vehicle according to at least one of claims 62 to 65 characterised in that this gearbox has at least two interengaging gearwheels and that this position-variable gearbox element is provided to be transferred from a first position where the rotary movement of at least one gearwheel is fixed relative to the gearbox component into a second position where this gearwheel can rotate freely relative to this gearbox component.

67. Motor vehicle according to claim 66 characterised in that this component part is a gearbox shaft.

68. Motor vehicle according to claim 66 or 67 characterised

in that this gearbox has at least two parallel gearbox shafts as well as a number of teeth mounted on these shafts which interengage with each other and that furthermore a shift device is provided through which at least one position-variable gearbox element can be transferred into a predetermined target position in which the rotary movement of at least one of these gearwheels is fixed relative to the gearbox shaft on which the gearwheel is mounted and at the same time the rotary movement of at least another gearwheel is blocked relative to the gearbox shaft on which this gearwheel is mounted, and that through a change in the fixing of these gearwheels relative to the relevant gearbox shaft at least three different ratios of the gearbox in a first direction cause the reaching of a neutral transfer position where the gearbox transfers no rotary movement and the reaching of a transfer position where the gearbox transfers a rotary movement into a second rotary direction

69. Method according to at least one of claims 64 to 68 characterised in that the assessment criterion underlying the learning mode takes into account the displacement path of a position-variable gearbox element from neutral position into the position associated with each one certain ratio.

70. Motor vehicle according to at least one of claims 64 to 68 characterised in that this position-variable gearbox element is a synchronizer sleeve which is fixed rotationally secured relative to a gearbox shaft and which can move from a first position which corresponds to a first ratio into a second position which corresponds to a second ratio wherein this assessment criterion underlying the learning mode takes into account the displacement path between this first and second position.

71. Motor vehicle according to at least one of claims 65 to 68 characterised in that this first assessment criterion

takes into account a statistical analysis of a predetermined number of position data values which were detected for each of the predetermined target positions.

72. Motor vehicle according to at least one of claims 62 to 71 characterised in that the clutch device can adopt at least two operating states, namely a first operating state wherein the engine and gearbox are separate from each other and a second operating state where the engine and gearbox are connected together for transferring a torque.

73. Motor vehicle according to claim 72 characterised in that this clutch can adopt an operating state where the engine and gearbox are connected together rotationally secured.

74. Motor vehicle according to claim 72 or 73 characterised in that this clutch device can adopt a number of operating states wherein one operating state causes the engine and gearbox to be substantially separate from each other and that only one slight torque is transferred and wherein the other operating states cause a torque to be transferred at a predetermined level through this clutch.

75. Motor vehicle according to claim 74 characterised in that this clutch device has a first torque supplying and discharging device as well as a second torque supplying and discharge device and that a medium is provided which connects together this first torque supplying and discharging device and this second torque supplying and discharging device to transfer a torque.

76. Motor vehicle according to claim 75 characterised in that this torque-transferring medium is a fluid.

77. Motor vehicle according to at least one of claims 62 to

76 characterised in that a clutch operating device is provided which causes a change in the operating states.

78. Motor vehicle according to at least one of claims 62 to 77 characterised in that this clutch device contains a single-disc dry clutch.

79. Motor vehicle according to claim 77 and 78 characterised in that the clutch operating device operates a disengagement device of this single-disc dry clutch.

80. Motor vehicle according to at least one of claims 77 to 79 characterised in that this clutch operating device has at least one hydraulic cylinder wherein at least one piston is mounted displaceable in this hydraulic cylinder.

81. Motor vehicle according to claim 80 characterised in that the clutch operating device has two hydraulic cylinders wherein this first hydraulic cylinder is a master cylinder which produces a fluid pressure and this second hydraulic cylinder is a slave cylinder whose piston is moved as a result of this fluid pressure wherein this piston is in active connection with this clutch device.

82. Motor vehicle according to at least one of claims 79 to 81 characterised in that this displaceable piston operates this disengagement device.

83. Motor vehicle according to at least one of claims 62 to 82 characterised in that a program controlled clutch control device is provided which issues control signals for controlling this clutch device.

84. Motor vehicle according to claim 83 characterised in that the program controlled computer unit and the clutch control device form a common computer unit.

85. Motor vehicle according to claim 83 or 84 characterised in that the clutch control device is connected to a command issue unit through which this clutch control device receives control signals which influence the control of this clutch device.

86. Motor vehicle according to claim 85 characterised in that this command issue device is integrated in the computer unit.

87. Motor vehicle according to claim 85 or 86 characterised in that this command issue device issues a first control signal to the clutch control device when the position of a position-variable gearbox element is to be changed wherein this first control signal causes the torque transfer between the engine and gearbox to be reduced or interrupted and that this command issue device issues a second control signal when the position data value detected during or after the position change of this position-variable gearbox element is sufficient for this assessment criterion wherein this second control signal causes this clutch device to adopt a predetermined operating state.

88. Motor vehicle according to at least one of claims 85 to 87 characterised in that this command issue device is connected to a shift desire detection unit which detects when a position change of this position-variable gearbox element is to be produced.

89. Motor vehicle according to claim 88, characterised in that this shift desire deduction unit recognizes when the user operates a gear operating lever.

90. Motor vehicle according to at least one of claims 62 to 89 characterised in that this gearbox is a manual shift gearbox.

91. Motor vehicle according to claim 89 and 90 characterised in that this shift desire deduction unit receives the signal of this sensor device and in the event of a change of this sensor signal causes this command issue device to issue the first control command.

92. Motor vehicle according to at least one of claims 62 to 89 characterised in that this gearbox is an automatic shift transmission.

93. Motor vehicle according to claim 92 characterised in that a gearbox control device is provided which issues control commands which cause a shift process of this automatic shift transmission.

94. Motor vehicle according to at least one of claims 62 to 93 characterised in that at least a second sensor device is provided to detect the operating values of this motor vehicle.

95. Motor vehicle according to claim 94 characterised in that this second sensor device has at least one sensor which is selected from a group of sensors which contains:

sensors for detecting a brake pedal position,
sensors for detecting the brake pressure on one or more points of the brake unit,
sensor for detecting the intake air speed,
sensors for detecting the throttle valve position,
sensors for detecting the accelerator pedal position,
a sensor for determining the amount of fuel supplied per unit time or during an injection process,
sensors for detecting an engine speed,
sensors for detecting a gearbox speed,
sensors for detecting a wheel speed,
sensors for detecting accelerations in the vehicle longitudinal directions,

sensors for detecting accelerations in the vehicle transverse direction,
sensors for detecting the pressure at predetermined points in a hydraulic system,
sensors for detecting the oil temperature,
sensors for detecting the cooling temperature,
sensors for detecting the external temperature,
sensors for detecting the ambient pressure,
sensors for detecting the electrical power discharged at the current consumers, such as climate control, rear windscreen heater etc.

96. Motor vehicle according to claim 93, 94 or 95 characterised in that this gearbox control device detects from a predetermined program at which point and in which position the actual position of this position-variable gearbox element is to be changed.

97. Motor vehicle according to claim 92 characterised in that a selector device to be operated by the user is provided through which the shifting of this automatic transmission is induced.

98. Motor vehicle according to claim 97 characterised in that this shift device contains a step shift device which causes the gearbox to be switched over into each next translation stage.

99. Motor vehicle according to at least one of claims 62 to 98 characterised in that the shift desire deduction device is integrated in the computer unit.

100. Motor vehicle according to at least one of claims 62 to 98 characterised in that the gearbox control device is integrated in the computer unit.

101. Motor vehicle according to at least one of claims 62 to 100 characterised in that this gearbox contains at least one gearbox section which allows an infinite alteration of the transfer ratio of two associated gearbox component parts wherein this at least one position variable gearbox element changes the translation ratio of this gearbox section.

102. Motor vehicle according to claim 101 characterised in that this assessment criterion contains the examination of a predetermined translation ratio of the gearbox.

103. Motor vehicle according to claim 101 or claim 102 characterised in that these position reference values each correspond to a predetermined speed ratio.

104. A method for monitoring the functions of a motor vehicle transmission substantially as herein described with reference to the accompanying drawings.

105. A motor vehicle substantially as herein described with reference to the accompanying drawings.

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Claims searched: 1 - 103

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Patents Act 1977
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Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): F2D (DCD)

Int Cl (Ed.6): F16H 59/70, 61/12

Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2296543 A	(MASSEY FERGUSON) Whole document relevant.	1 and 62 ar least.
X	EP 0422444 A	(ZEXEL) Whole document relevant.	1 and 62 at least.
X	EP 0217540 A	(ISUZU) See Figs 1 and 2.	1 and 62 at least.

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